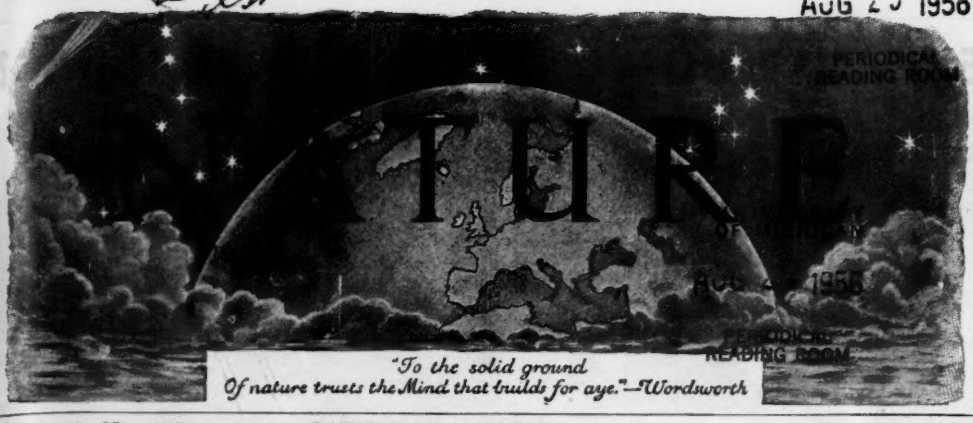
Desk
UNIVERSITY OF MICHIGAN
AUG 2 0 1956
PERIODICAL READING ROOM




AUG 4 - 1956
PERIODICAL READING ROOM

VOL. 178, No. 4527 SATURDAY, AUGUST 4, 1956 TWO SHILLINGS

C. Baker
OF HOLBORN LTD EST 1765

**APLANATIC MAGNIFIERS**

×6, ×8,

×10, ×15, ×20.

Cemented triplet lenses yielding well corrected images and flat fields of view. In handy single or double pocket mounts.

*Particulars on request:*
C. BAKER OF HOLBORN, LTD., METRON WORKS
PURLEY WAY, CROYDON, SURREY (CROydon 3845-6-7)
*Showrooms:* 244 High Holborn, London, W.C.1

TSL

*Jubilee Year*

1906-1956

Half a Century of Constant Research and Development

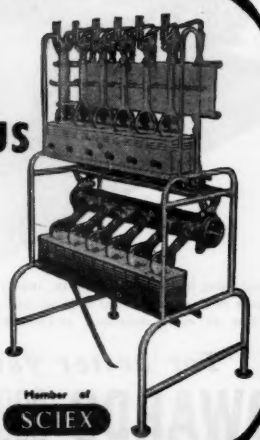
THE THERMAL SYNDICATE LTD.
P.O. Box No. 6 WALLSEND · NORTHUMBERLAND *Telephone: Wallsend 6-3242*
LONDON: 12-14, OLD PYE STREET, WESTMINSTER S.W.1. *Telephone: Abbey 5469*

B T L

**UNIVERSAL KJELDAHL APPARATUS**

- Interchangeable components for digestion and distillation, or a combination of both.
- Gas or electric heating boxes.
- Six unit assemblies, or multiples of six.

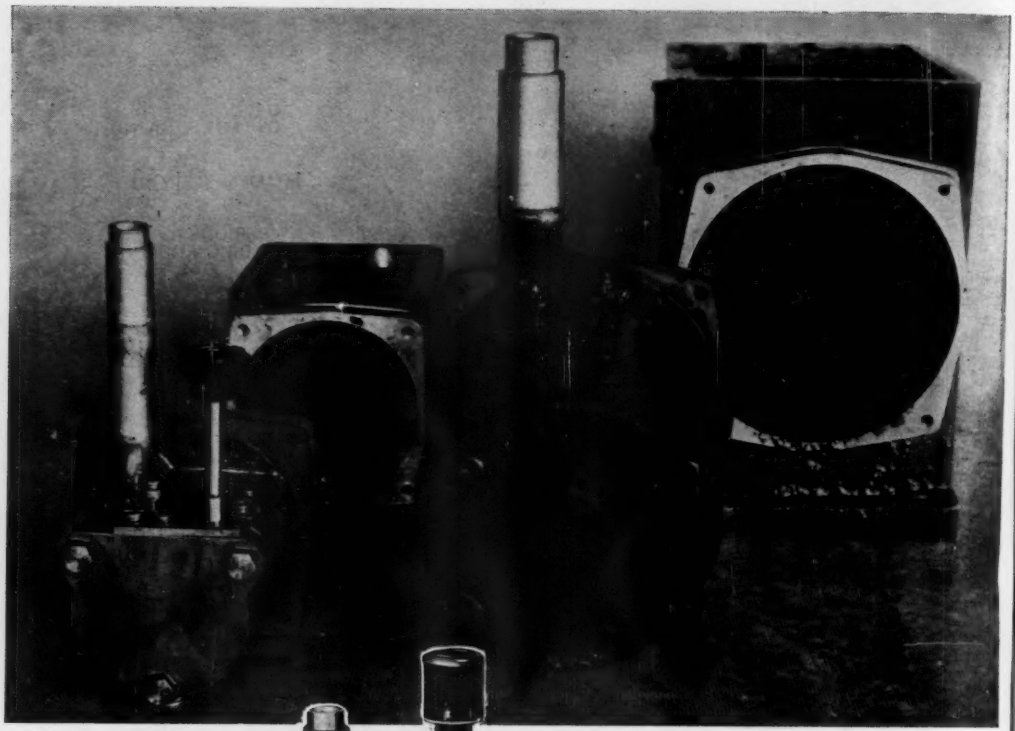
*Write for Technical Brochure T.53 for full particulars and prices.*

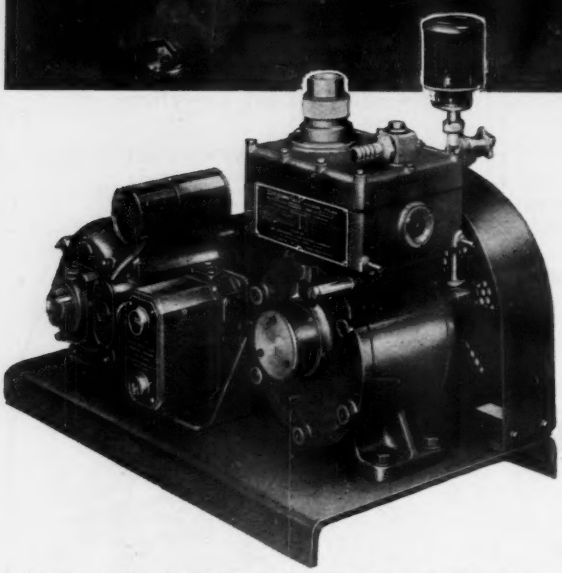


**BAIRD & TATLOCK**
(LONDON) LTD.
*Scientific Instrument Makers*
CHADWELL HEATH, ESSEX, ENGLAND

Member of SCIEX

# EXHAUSTING CONDENSABLE VAPOURS?





Illustrated is the 450 litre/min. model ISC450, one of the EDWARDS range of single and multi-stage air-ballasted rotary pumps with speeds of a few or many thousands of litre/min. SEND FOR FULL DETAILS.

**'SPEEDIVAC' ROTARY VACUUM PUMPS give the finest all-round pumping performance you can buy—WET or DRY, they keep their fast pumping cycles, handling all types of condensable vapours which do not readily dissolve or chemically attack the pump oil.**

**The unretouched photograph shows the interiors of the 'SPEEDIVAC' 1SC30 air-ballasted pump and a 'SPEEDIVAC' 1SC50 (NOT air-ballasted) after 90 hours *on the same circuit* for the distillation of essential oils, terpenes being the contaminant. The remarkable effectiveness of air-ballasting in preventing the fouling of the pump and oil is clearly shown.**

*For better vacuum service . . .*

**EDWARDS HIGH VACUUM LTD**

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

# NATURE

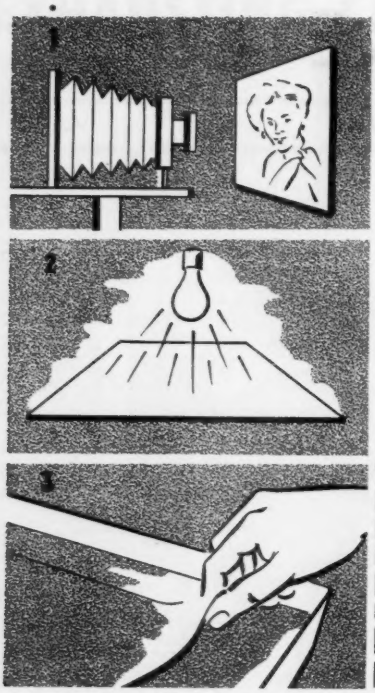
No. 4527 SATURDAY, AUGUST 4, 1956 Vol. 178

## CONTENTS

| | Page |
|---|---|
| Industrial Leadership and Education | 225 |
| Plastic Behaviour and Design of Steel-frame Buildings. By Prof. W. Fisher Cassie | 227 |
| W. A. Lane : a Guy's Surgeon. By Sir James Paterson Ross, K.C.V.O. | 227 |
| Dielectrics. By Dr. B. Szigeti | 228 |
| Applied Solar Energy. By Dr. H. Heywood | 229 |
| Nuclear Engineering. By Prof. W. Murgatroyd | 229 |
| Treatise of Zoology. By Prof. C. H. O'Donoghue | 230 |
| The George R. Agassiz Radio Telescope of Harvard Observatory. By Prof. Bart J. Bok | 232 |
| The Gough Island Scientific Survey, 1955–56. By M. W. Holdgate, R. W. LeMaitre, M. K. Swales and M. N. Wace | 234 |
| Nuclear Magnetic Resonance and Electron Skin Resonance. By Dr. D. J. E. Ingram | 236 |
| Obituary : Mr. E. B. Wedmore, C.B.E. By Prof. J. Greig ; Dr. C. G. Butler | 238 |
| News and Views | 239 |
| New Nature Reserves in Britain | 246 |
| The Museums Association : Annual Conference in the Netherlands | 247 |
| Meteorological Programme of the International Geophysical Year | 247 |
| The Physical Society : Annual Report for 1955 | 248 |
| The Deli Palm | 248 |
| Age of Uraninites from Blind River, Ontario. By R. K. Wanless and R. J. Traill | 249 |
| Viviparous Caecilians and Amphibian Phylogeny. By Dr. H. W. Parker | 250 |
| Dimorphism in the Portuguese Man-of-War. By A. H. Woodcock | 253 |
| Stimulation of Coleoptile- and Root-Growth by Extracts of Maize. By S. Housley, A. Booth and I. D. J. Phillips | 255 |

Letters to the Editors :

| | |
|---|---|
| Drift Experiments with Radioactive Pebbles.—C. Kidson, D. B. Smith and Prof. J. A. Steers | 257 |
| Radiation-induced Changes in Reactivity of Bovine Fibrinogen.—Dr. Peter Rieser and Robert J. Rutman | 257 |
| Paper Electrophoresis of Rat Pancreatic Juice and Water-Soluble Proteins of the Pancreas.—Dr. Hanna A. Rothschild and L. C. U. Junqueira | 258 |
| Comparison of the Metabolic Stimulating Action of Aspirin and Thyroid.—W. D. Alexander and Miss K. W. M. Johnson | 259 |
| Synthesis and Biological Activity of a New Potent Analogue of Oxytocin.—R. A. Boissonnas, St. Guttmann, P.-A. Jaquenoud, J.-P. Waller, H. Konzett and B. Berde | 260 |
| *In vivo* Inhibition of Oxidative Phosphorylation of Rat-liver Mitochondria by 2 : 4 Dinitrophenol.—Dr. V. H. Parker | 261 |
| An Estimation of the Nature of Nucleoproteins by an Analytical Method.—A. Knobloch and Dr. R. Vendrely | 261 |
| Serotonin and Connective Tissue.—Dr. G. Asboe-Hansen and O. Wegelius | 262 |
| A Substance promoting Hatching and Liberation of Young in Cirripedes.—Dr. D. J. Crisp | 263 |
| Production of Patulin in Apple Fruits by *Penicillium expansum*.—Dr. P. W. Brian, G. W. Elson and D. Lowe | 263 |
| Response of Animal Fibres to Acid Attack.—Dr. J. Menkart and Jeanne Detenbeck | 264 |
| Measurement of Mean Red-Cell Thickness by the Use of a Probability Function.—Dr. Eric Ponder and Dr. Celia Barreto | 265 |
| Electrical Properties of the Plasma Membrane of Erythrocytes at Low Frequencies.—T. P. Bothwell and Prof. H. P. Schwan | 265 |
| Energy Relations of Mitotic Activity in Mouse Hair Bulbs.—Prof. W. S. Bullough and Edna B. Laurence | 266 |
| Assay of Spider Venom and Antivenene in *Drosophila*.—Dr. S. Wiener and Dr. F. H. Drummond | 267 |
| Histamine and Histidine in Excreta of the Blood-sucking Bug *Rhodnius prolixus*.—J. S. Harington | 268 |
| The Small Saphenous Vein as a Route for Intravenous Injection in the White Rat.—Dr. J. W. Everett and Dr. C. H. Sawyer | 268 |
| A pH Gradient Agar Plate.—Dr. L. E. Sacks | 269 |
| Generic Status of *Glossopteris*, *Gangamopteris* and *Palæovittaria*.—K. R. Surange | 270 |
| Polyploidy and Radiosensitivity.—Dr. Alan D. Conger and A. Helen Johnston | 271 |
| *Allium neapolitanum* : a Mixed Species.—Maria Kefallinou Hattersley-Smith | 272 |
| A Gene for Eyelids Open at Birth in the House Mouse.—Prof. J. H. Bennett and G. A. Gresham | 272 |
| An Adhesive for labelling Animals exposed to Sea-Water over Long Periods.—J. T. Conover and M. E. Pierce | 273 |
| An Interfacial Barrier observed during Liquid–Liquid Extraction of Uranyl Nitrate.—Dr. J. B. Lewis | 274 |
| Relation between the Volume of a Liquid and its Internal Energy.—M. B. King and R. F. Strickland-Constable | 275 |
| Production of Carrier-free Cobalt-58 by Pile Irradiation of Nickel.—C. E. Mellish and J. A. Payne | 275 |
| Ca II Emission Lines in the Twilight Spectrum.—Prof. A. Vallance Jones | 276 |
| Sudden Absorption of Atmospherics due to Increase in Cosmic Ray Intensity.—Jules Aarons and William R. Barron | 277 |
| Representation of the Inelastic Deformation of Concrete by means of a Mechanical Model.—Dr. Henry J. Cowan | 278 |
| Creep in Coal at Room Temperature.—C. D. Pomeroy | 279 |
| Photographic Sensitizers in Gelatin.—G. Russell | 280 |




## Half-tone printing plates
### *with an ordinary studio camera*

It is now possible to make half-tone printing plates with an ordinary sheet-film camera. 'Kodalith' Autoscreen Ortho Film has the half-tone dots incorporated in the emulsion, making process cameras and half-tone screens unnecessary.

Autoscreen Film can be used with pre-sensitized metal plates to make half-tone or combination line/tone plates for reproduction by office printing machines. Type matter and line drawings can be exposed at the same time as photographs or wash drawings.

*Please send for details.*

1. Make the normal detail exposure.
2. Flash with yellow light for contrast control.
3. Develop, with controlled agitation.

**Kodalith**
***Autoscreen***
**Ortho Film**

Kodak Limited, Industrial Sales Division, Kodak House, Kingsway, London, W.C.2.

*'Kodalith' is a registered trade-mark.*

## TWENTY MILLION MEGOHMMETER

MODEL 29

A direct reading megohmmeter covering from 300,000 ohms to 20 million megohms in seven decades. Internal test voltages of 85 v. and 500 v. are provided. The Model 29 is used both in the test room and in the manufacture of resistors, condensers, cables and dielectrics.

Other resistance measuring instruments in the E.I.L. range include:

Model 47A .. 100 microhms to 1,200 ohms.
Model 35 .. 200K to 200,000M
Model 31 .. $10^7$ to $10^{14}$ ohms.

E·I·L

*Conductivity to Infinity*

**ELECTRONIC INSTRUMENTS LIMITED · RICHMOND · SURREY · ENGLAND**

RIChmond 5656

E.I.L. 23

# INDUSTRIAL LEADERSHIP AND EDUCATION

FOLLOWING on an admirable article, "Trade Unions To-day", in the *Round Table* last December, the *Political Quarterly* devoted the whole of its January–March number to the examination of trade union problems, the contributors including some whose work, like that of B. C. Roberts in "Trade Union Government and Administration in Great Britain" and H. A. Clegg in "General Union", has already thrown fresh light on the problems that confront British trade unions in the Welfare State with its full employment. These studies testify to the need for change in the structure and even in the functions of the unions if they are to adapt themselves to serve effectively the needs of the day. They indicate no less emphatically that change and adaptation must come as a result of inquiry and pressure from within and not from without; though criticism from without can point to weaknesses and may advance constructive suggestions for reform, and it can help to create the understanding and climate of opinion which favour reform. The *Round Table*, for example, points out that the need to accept the duties and responsibilities of full employment falls upon the unions, and the passing of power into the hands of the trade unions is a fact that must be accepted. The utterances of responsible trade union leaders regarding automation itself have shown that this is fully recognized by them, and that they are also aware that there are certain economic laws that they must not neglect. But while the leaders may have shed doctrinaire views, they have as yet largely failed to induce their members to accept the responsibility for co-operating to the full extent with management in increasing the rhythm of production from which all demands must be met. This co-operation is a prime condition if we are to enjoy the benefits which automation offers, and it is a grave weakness in the report from the Department of Scientific and Industrial Research that it appears to lay the responsibility solely on the side of management. On the contrary, the challenge of prosperity which automation offers must be accepted by the trade unions also, and dealt with by them in terms of efficient production as the *Round Table* suggests.

The *Round Table* outlines a positive policy for the trade unions which contrasts sharply with the silence of the Department of Scientific and Industrial Research. The unions, it suggests, should co-operate to the maximum in acquiring industrial techniques to maintain increased standards of living, and should accept responsibility for introducing modern schemes of reorganization and reconstruction that mean re-deployment of labour, re-assessment of tasks and alterations in the status of jobs. The unions, it is emphasized further, should discard the untenable theory that we can enjoy increased standards of living with decreased or static production-levels; but they should insist on the maximum possible share for the producer in our expanding economy. Union policy and constitutions should be examined with the view of eliminating customs and practices which prevent work becoming easier and new production methods being adopted, and should insist on the elimination of malpractices of employers in this sphere. Further, while the trade unions should retain their power to secure the fulfilment of the just and fair demands of their members, they should equally remember that trade unionists are members of the community and that their rights are conditioned by the rights of others.

These ideas are largely reflected in the contributions to the *Political Quarterly*, the most important of which are those which address themselves to the practical problems of the ways in which the trade union organization can be adapted to enable the unions to meet their new responsibilities and to throw up leaders capable of displaying the economic statesmanship of the highest order that is now demanded on so broad a front. Mr. B. C. Roberts, for example, points out how much depends, in a democracy like that of Britain, on the willingness of the trade unions and the employers' organizations to face the issues that the Welfare State has posed. The whole future of the Welfare State depends on the ability to overcome the inflationary spiral which now afflicts the economy by increasing the volume of goods and services or by reducing purchasing power; and there is urgent need to change industrial wage structures in the light of technological developments and in the interest of obtaining higher rates of production. Whether the existing system of collective bargaining is capable of achieving the changes required may be doubted, and Mr. Roberts suggests that possibly a more radical approach may be required, such as agreement by the unions to a less centralized system for determining wage-rates. Again, he points out that technical developments in industry, the growth in complexity of trade union functions and the increase in size of the unions have placed increased responsibilities on trade union leaders, whose task is rapidly becoming a professional occupation, demanding a high degree of skill such as can only be obtained by experience and training. While, however, the selection of trade union officials, their tenure of office, remuneration and opportunities for promotion have become, at least in the large organizations, matters of crucial importance, many trade unionists are still reluctant to examine the implications of these questions. The fear of bureaucratic control is justifiable, and it is clear that there is often a lack of understanding between headquarters and the local branches and rank and file of a union, while the national prestige of the Trade Union Congress is not matched by the power of its General Council, which cannot compel an affiliated organization to follow the policies it wishes to see adopted.

Here again it is a question of influence rather than power, in which the character and personality as well

as the administrative capacity of the trade union official are all-important. Increasingly he requires exactly those qualities which, as the Acton Society Trust's recent inquiry has shown, industry is more and more finding in those who have entered from the university or grammar school, rather than among those who have risen from the factory floor to management status.

This tendency is an inevitable consequence of the broadening of educational opportunity, and the present distrust of the college-trained trade unionist and feeling against an educated *élite* must disappear in the unions, as they have largely done in industry, if the unions are to secure the talent they need to render their members and the community the service now required of them.

To this problem Mr. H. A. Turner's article on trade union organization and especially Mr. J. A. Mack's article on trade union leadership are devoted, though particular aspects of it also appear in those in which Mr. Clegg discusses the problem of strikes and Mr. Guy Revitt the structure of collective bargaining. Mr. Turner is concerned with questions of size, and touches on those difficult demarcation issues which automation is likely to accentuate. He indicates the need for regrouping and for decentralization as unions and amalgamations grow in size; but it is equally clear that any such measures make large demands on leadership, both at the national and at the regional or local level. It is brought out even more clearly by Mr. Mack, who, moreover, points out that the present confusion in the British trade union movement is derived directly from the failure of union leadership to exercise the responsibilities which are a condition of the proper use of the growing power of the unions, at least on the theory which has sustained the development of the movement for the past thirty years.

Mr. Mack remarks that the leaders are for the most part singularly unaware of the disadvantages under which they labour. While on the whole the unions get the best men available, he quotes Mr. Roberts's verdict, in "Trade Union Government and Administration in Great Britain", that the work of the union official produces tough, self-reliant, pragmatic individuals, men of courage and determination, who better than most know how to take a decision and stand by it. Their self-confidence makes them determined advocates and excellent negotiators, but contrasts sharply with the more sophisticated approach of the politician to problems, and accounts for the contempt they sometimes display to those who have been trained in a more intellectual school. It also accounts for a disposition to let things run, to solve their problems of organization as they arise and to resist any attempt at a major reconstruction of the relations within the individual unions and between unions.

These practical problems of reorganization, however, are becoming more pressing. The fundamental autonomy of the British trade unions in the wider society is not yet even threatened. The formation of the Peoples League for the Defence of Freedom and the activities of the Free Press Society out of which it has grown, as well as the pamphlet, "Spotlight on Trade Unions", recently published by the *Daily Mirror*, are pointers to which the trade unions would be wise to pay attention. The preservation of the autonomy of the unions is bound up with their capacity to maintain internal law and order, and to improve the economic and industrial status of their members without wrecking the national economy.

While most of the leaders may now be prepared to accept the new responsibilities, that will only be reflected in the policy and practice of the unions in so far as there is closer contact and understanding between the leaders and the ordinary members. Education is likewise the key to the removal of those problems which dissensions among the unions create. As the *Round Table* emphasized last December, the leaders must increasingly address themselves to the education of members in the facts of modern life.

To a limited extent some of this educational work, the importance of which has become even more apparent in the recent issues raised by automation, could be done outside of the unions. It is only likely to be fully effective if it is also undertaken from within, and it is one of the most important of the ways in which trade union leaders can help to deal with the problems which automation involves. If they are to do this effectively, however, and assist the unions to make the contribution to the increase of productivity that they alone can give, it is increasingly important that the unions should draw into their leadership a fair share of the best ability available.

This means, as has been indicated, that the unions must give increasing attention to the recruitment and education of their officials. If closer contact and understanding between the official and the ordinary member are needed, it is no less essential that there should be close contact and understanding between the official and the managers, Civil servants, Ministers and others with whom he is increasingly required to co-operate as well as to negotiate. He must be able to meet them on level terms, and he cannot do so unless he has the scientific and technical knowledge which are demanded in industrial and economic decisions to-day.

Here, then, the question of the function of the trade unions to-day, and their reorganization to make their full contribution to the welfare of their members and of the community as a whole, is linked up with the expansion of technical and technological education and with educational policy as a whole. In so far as technical and technological education is planned to provide industry with the leaders it needs, it must provide leadership for the unions as well as executives for industry. Moreover, co-operation as well as the provision of such leaders will be increasingly facilitated in the measure in which leaders in the unions and managers and executives in the factories have received part at least of their training side by side. In the range of courses which are offered, whether by the university, the college of technology or the technical school, there should be opportunities for the trade unionist leader to acquire the new knowledge and skills he needs, as well as for the tech

nologist or the manager to refresh his mind or extend the range of his knowledge. Refresher courses and courses of training for management should be framed with such possibilities in mind. Similarly, the trade unions must increasingly seek to attract into their service some of the ablest minds which the universities and other institutions can put at their disposal.

It is with such issues as these that the Government should be showing concern. There has as yet been little sign that it has a concerted policy, or that it is prepared to take the measures that will be required to win support for an adequate policy of technical education, including education for management as well as preparation of the community for educational change. It is a Government responsibility to see that the educational policy of Britain provides effective safeguards against the ignorance and prejudice which are the most dangerous saboteurs of development and industrial efficiency and prosperity. To dispel misconceptions, to establish confidence and to promote adaptability are the first objectives to which the Government should now be directing its educational and its economic and welfare policies. There is much to be done; but the Prime Minister's statement on June 5 on economic policy and automation gave little hint that the Government is aware of the needs.

## PLASTIC BEHAVIOUR AND DESIGN OF STEEL-FRAME BUILDINGS

### The Steel Skeleton

By Prof. J. F. Baker, M. R. Horne and J. Heyman. Vol. 2: Plastic Behaviour and Design. Pp. x+408. (Cambridge: At the University Press, 1956.) 63*s*. net.

DESPITE the fact that the word 'design' appears in the sub-title of this volume, the steelwork designer might, at first glance, imagine that there is little here for him. This, however, would be an erroneous impression, for it has never been the custom of Prof. J. F. Baker's team to consider an elegant theory as an end in itself. Theory and design are complementary and, in this book, their interrelation has been taken for granted—so much so that important rules of design are in one instance buried in a sub-section. The designer certainly will find adequate guidance in designing steelwork by the plastic method; but he must be willing to relate theory to design, and not expect to find routine procedures handed to him ready-made.

This volume brings the story of Vol. 1 (see *Nature*, 174, 1026; 1954) up to the present day. The Bristol and Cambridge researches are fully described; but many structural engineers, alive to recent developments, must already know the story, as it has appeared over the years in various technical journals. It is an instructive tale to those who have yet to read it; but most will turn with a sense of satisfaction to Chapters 7 and 8, where fundamental theorems and general methods of analysis, respectively, are discussed. Here are the roots of the matter.

The latest developments of plastic design are considered in the chapters on 'shakedown' and on minimum-weight design. 'Shakedown' refers to collapse under live and dead loads which are independently variable, and the true economy of design is discussed in the second of these chapters. Although it was possible, in the early days, to check plastic theory for shed-type frames by full-scale tests to destruction, it is clearly out of the question to attempt the same procedure with multi-story frames. The behaviour of beams and stanchions in such structures can be predicted only from separate small-scale tests and by logical deduction from the results so obtained.

The 'question marks' or points which are still debatable are, therefore, mostly related to the behaviour of stanchions, and, in the book, a careful survey is made, in three chapters, of all the relevant experimental and theoretical data. The forty-five different types of loading to which a continuous stanchion might be subjected are examined, and nine of the most likely more closely studied. Even this simplification leaves a very wide and complex field in which work remains to be done. Perhaps the other 'question mark'—that of the behaviour of joints—might have had more mention, but knowledge on this point is scarcely yet at the text-book stage.

Few people during the Second World War knew, as they lay in their Anderson table-shelters, that they were taking part in a test of the principles of ductility and continuity, as applied to structural design. Chapter 17 describes how from the early success of these shelters, which were the first practical structures designed by the plastic theory, grew the two hundred buildings that have proved the effectiveness of the method. It was the frame of a cinema in Bristol which raised the early queries in the minds of Prof. Baker and his colleagues, and it is perhaps fitting that one of the first multi-story frames designed by the new method should be erected in London for the firm of Technicolor, Ltd.

We are still in the early stages of this new development. Progress is likely to be slow if steel designers and fabricators remain too conservative. Visiting American architects admired the slender unity of Hunstanton Secondary School—the first multi-story frame by the plastic method. We should remember that the advance described in this volume is a British development: British architects and structural engineers should be the first to use its advantages. Certainly to the architect the plastic method opens wide opportunities for new structural shapes in steel, and, even if he cannot follow the mathematics, he will find the chapters on load factor and on application and design of real professional value. To the structural engineer this book is of vital importance. He neglects it at his peril unless he is close to retirement. This is the stuff of the future.

W. FISHER CASSIE

## W. A. LANE: A GUY'S SURGEON

### Sir William Arbuthnot Lane, Bt.

An Enquiry into the Mind and Influence of a Surgeon. By T. B. Layton. Pp. viii + 128 + 8 plates. (Edinburgh and London: E. and S. Livingstone, Ltd., 1956.) 21*s*. net.

THIS is a remarkable little book which will be of interest to the large number of surgeons of this generation to whom Lane is known only because his name is attached to certain beautifully designed instruments, and who must therefore wish to know more of the man and his work. The book is dedicated

to all Lane house-surgeons; but it is bound to be welcomed by all old Guy's men who, though they may not have served him as housemen, may have dressed for him or otherwise come under his influence in their student days. It will also be read with care by those who, having listened to Lane's disciples, have been puzzled by a certain reserve or qualification in their tributes to his memory. "He was such a good technician that he was able to get away with methods in which others couldn't follow him, and that's why he was so criticized"—a remark of this nature calls for an explanation, and Mr. T. B. Layton's inquiry is most helpful in elucidating the mystery which has long surrounded Lane's work and even his reputation.

Lane's father was an army surgeon, and his childhood was spent in many parts of the world as the young family followed the regiment on foreign service. It is clear that from his earliest years Willie had to take responsibility and fend for himself; though he grew up rather a shy young man, he must have learned independence and self-confidence from his early experiences. As a student at Guy's Hospital he made few friends, partly perhaps because he never had much money to spare for entertainment and recreation. There must have been some such explanation for his rather isolated existence, because later in life he took great delight in entertaining large parties at home, and was one of the first surgeons in London to welcome visitors to his operation theatre.

He entered surgery through the dissecting room, where he devoted special attention to the structure of bone and the mechanics of joints. He was particularly interested in anatomical changes in spinal joints which resulted from occupational stress; and his study of the handicap which a fracture might inflict upon a working man made him severely critical of the orthodox methods of treatment and provided the incentive to improve the results. This led to his outstanding work on the treatment of fractures by open operation and internal splinting.

As a technician he was supreme, and realizing the harm which antiseptics could do in a wound, he introduced his aseptic methods, using long sterile instruments and never touching anything which went into the wound. Mr. Layton's thoughtful and thorough inquiry into the reasons why Lane adopted this technique has not produced a very satisfactory answer. It is clear that "he did not know much if anything about bacteriology", and this must account for his persistent inability to distinguish between the risks of operating upon open as distinct from closed fractures. We know that he refused to learn from the past; but it is a shock to read that he was unable to learn from his own experience. His contemporaries must have recognized this failing, and their severe criticism of his practice of operating on every closed fracture is therefore readily understandable since it must have appeared to them to be just another error of judgment.

His interest in fractures arose out of sympathy with the working man, and his interest in the colon arose "out of sympathy with a particularly sad type of female patient whose chief complaint was pain in the lower part of the trunk". Lane's interest in physiology was "relatively small", but he was an evolutionist with a great interest in "vestiges" and conceived the idea that the whole large intestine was a "vestige". At any rate it could be harmless only if it was empty, for its contents made people "toxic", and it was on this assumption that he based his advocacy of colectomy. Sir Arthur Keith summed up his lack of scientific background in the remark: "I should hardly call him a clever man. He was emotional and highly strung; a man of feeling".

Lane was distinguished not only for his technical skill but also for his exemplary behaviour towards his assistants, including his nurses who were devoted to him, and to his patients. He was always self-controlled, dignified and honourable. He set very high standards for himself and for his team; but although he did not overlook faults in others, neither did he try to shelter himself behind his subordinates when things went wrong. Many of those around him realized that they were being "mesmerized", but they could forgive him his faults because, as Sir Cooper Perry said of him, "with it all he was such a gentleman".

J. Paterson Ross

---

# DIELECTRICS

## Dielectrics and Waves

By Prof. Arthur R. von Hippel. Pp. xii+284. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 128*s*. net.

## Dielectric Materials and Applications

Edited by Prof. Arthur R. von Hippel. (Technology Press Books in Science and Engineering.) Pp. xii+438. (Cambridge, Mass.: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 140*s*. net.

PROF. A. R. VON HIPPEL is very strongly against the view that as science advances the scientists have to become more and more specialized. He is convinced that exactly the opposite is the case: as our knowledge grows, old boundaries vanish and no scientist can afford to ignore what happens in fields outside his own. Dielectrics is a particularly suitable subject to demonstrate the interdependence of the various branches of science as it is of interest to so many people—to the physicist, chemist and electrical engineer, to the pure and applied research worker and the development engineer alike. To make these people feel at home with each other is the principal aim of these two books.

The first book, "Dielectrics and Waves", was written by von Hippel alone, and deals with the fundamental aspects of the interaction of dielectrics with electromagnetic waves. The first part of this volume gives an account of the macroscopic theory of polarization, magnetization and dielectric loss, while the second part develops the atomic theory of dielectrics, in particular the foundation of wave mechanics, the structure and energy-levels of the atoms and the spectra of atoms and gaseous molecules.

In contrast to atoms and gaseous molecules, liquids and solids are treated in rough outline; only a few selected topics, such as ferro-electricity and piezo-electricity, are discussed more thoroughly.

The presentation is very good. Although the author often goes into considerable detail, in particular where atoms and molecules are concerned, and does not attempt to hide all the difficulties, the book nevertheless makes pleasant reading. There are a few passages likely to lead to misunderstanding. There is, for example, a statement at the beginning of Chapter 24, from which those not acquainted with the subject are bound to conclude that in a consider-

able number of molecules the atoms are held together mainly by Van der Waals forces. The reader may also come to false conclusions concerning the internal field, as the Clausius–Mosotti equation is given far too much prominence. Although it is pointed out that there are some objections to this equation and the alternative Onsager formula is also discussed, nevertheless many readers may get the impression that the validity of the Clausius–Mosotti formula is much wider than it actually is. This idea has led to many mistakes in the past and it should be discouraged.

Apart from minor criticisms of this type, a great variety of readers will find the book instructive and useful. There is every reason for hoping that the author will meet with considerable success in his main aim, namely, in helping the physicist, chemist and electrical engineer to understand one another and in making them interested in each other's work.

The second book, "Dielectric Materials and Applications", is based on papers presented at a symposium. It starts with a theoretical introduction by von Hippel which, on the whole, is a very much shortened version of the contents of the first book. The rest of the second book, consisting of papers by twenty-one different contributors, deals with a great variety of practical aspects connected with dielectrics, including measuring techniques, dielectric materials used in all sorts of electrical equipment and devices, from power cables to memory devices, and there are also three papers on the dielectric requirements of the American army, navy and air force. The book also contains very extensive tables on dielectric data. Anybody who wants to acquaint himself with the problems arising in the practical applications of dielectrics will find this book an excellent introduction to the subject.

B. Szigeti

## APPLIED SOLAR ENERGY

### Proceedings of the World Symposium on Applied Solar Energy

Phoenix, Arizona, November 1–5, 1955. (Sponsored by The Association for Applied Solar Energy, Stanford Research Institute, University of Arizona.) Pp. 304. (Melno Park, Calif.: Stanford Research Institute, 1956. Copies available from the Association for Applied Solar Energy, Phoenix.) 5 dollars.

THE scope of this first World Symposium on Applied Solar Energy has already been described in some detail in *Nature* (177, 110; 1956), and in reviewing the proceedings only brief mention will be made of the contents. The volume consists of twenty-four main papers delivered at the Phoenix Conference, and includes the opening remarks by Lewis W. Douglas, the welcoming luncheon address by Sir Edward Bullard, and the banquet address by John Jay Hopkins, "Towards a New Heaven and a New Earth". There is also a record of the panel discussions on solar house heating, architectural problems, and the future of applied solar energy. A description of the Solar Engineering Exhibition is included.

The general extent of applied solar energy research is now well known and includes low-grade heat applications such as water and house heating, cooking, water distillation, high-temperature solar furnaces, mechanical and electrical power, refrigeration, chemical energy conversion and artificial cultivation of algae. All these applications are described in considerable detail by experts who have personally conducted research in the particular field concerned, and together the papers give a comprehensive picture of the present position. It is perhaps the future possibilities that will most interest the general reader. Economics is the controlling factor, and careful design is necessary to reduce the equipment to the most simple form. The introduction of new materials and methods of construction will greatly reduce the capital cost of equipment. Applications are mostly limited to regions of high solar radiation, and in such localities solar energy could be integrated with existing forms of energy supply. The greatest scope lies in countries which are located in lat. 20°–40° N. and S., and which are at present industrially undeveloped. Solar energy must in the future fulfil an essential need in such areas as development and research proceed.

The promoters of the Symposium are to be congratulated on producing in a relatively short time a volume which is very well printed and clearly illustrated, and which comprises so much interesting information on the subject.

H. Heywood

## NUCLEAR ENGINEERING

### Principles of Nuclear Reactor Engineering

By Samuel Glasstone. Pp. ix+861. (London: Macmillan and Co., Ltd., 1956.) 60*s*. net.

THE earlier work, "The Elements of Nuclear Reactor Theory", in which Dr. S. Glasstone collaborated with Dr. M. K. Edlund, has become a standard text-book for the rapidly growing number of nuclear reactor engineers. To say that my immediate reaction to this newer work by Dr. Glasstone was one of disappointment is not to belittle the book, which is the most complete of its kind yet published. It is aimed particularly at "the practising engineer who wishes to know something of the impact of nuclear energy on his professional activities" and "students in engineering schools at the senior or first year graduate levels". The difficulties in catering for the two classes of reader in the same book are apparent in the text.

After a 57-page summary of the scope of the book, three chapters are devoted to basic nuclear physics and reactor theory. Thanks to a more concise treatment of slowing-down theory, and to the omission of much of a purely mathematical nature, the contents of the earlier book have been compressed with perhaps some gain in lucidity. Enough theoretical and experimental information is now available on fast reactor theory to warrant a much fuller discussion than is given. Wisely the terms 'geometrical buckling' and 'material buckling' have been omitted, as has also (perhaps unwisely) the 'track length' explanation of the misnomer 'neutron flux'. There is an excellent discussion of the effects of variation of lattice parameter.

The chapters on instrumentation and control are very clearly written, though in a book of this scope perhaps the automatic control of reactor systems should be accorded greater importance. Actinide chemistry is dealt with at some length in the chapter on fuel processing and is followed by a discussion of the principles of chemical separation. The build-up of higher isotopes in a reactor justifies a much more comprehensive treatment than it receives here. In

the chapter on materials, the extraction and fabrication of uranium and thorium are dealt with briefly, and a few lines are devoted to alloys of these elements. Reactor materials and the effects of irradiation upon them are concisely described. Two chapters follow on radiation protection and shielding. The important field of the disposal of radioactive waste merits a fuller and more quantitative treatment.

The difficulty of aiming at a wide audience is particularly apparent in the chapter on thermal aspects of nuclear reactor systems. Most of the elementary treatment of heat transfer and fluid flow could well be omitted. The resulting space could profitably be devoted to a fuller treatment of the temperature distribution inside a reactor, the problems arising in matching the reactor to a power cycle, and the thermal aspects of the dynamics of reactor systems. The penultimate chapter deals in a rather tedious manner with design variables, and the book is completed by description of a number of reactors.

Perhaps the major criticism of this book is that, although officially sponsored and published at the time of the Geneva Conference, it is based on pre-Geneva information. No doubt steps will be taken to correct this in later editions. W. Murgatroyd

---

## TREATISE OF ZOOLOGY

Traité de Zoologie

Anatomie, Systématique, Biologie. Tome 17: Mammifères. Les Ordres: Anatomie, Ethologie, Systématique. Publié sous la direction de Pierre-P. Grassé. Fascicule 1: Pp. viii+1,170. Fascicule 2: Pp. vi+1,171–2,300. (Paris: Masson et Cie., 1955.) Paper bound, 11,000 francs; cloth bound, 11,800 francs each.

IT is a welcome task to review another volume of the "Traité de Zoologie" edited by Pierre-P. Grassé; and an imposing volume it is, being composed of two fascicles each larger than some of the preceding volumes—it is perhaps unavoidable that the price is also imposing. This is one of the two volumes devoted to mammals; the first, which has not yet appeared, will deal with the anatomy and reproduction of the mammals in general. The present volume is devoted to the systematics, with quite a fair amount of the relevant special anatomy of skeleton, brain, viscera and urinogenital system, and the biology in quite a wide sense.

Throughout the systematic arrangement, adequate weight is given to the fossil forms and to discussions of their relationships with living groups. In this connexion the sections on fossil Proboscidians, on fossil Perissodactyla, on fossil Simioidea and fossil man appear particularly useful. The classification of the Eutherian mammals owes a good deal to that of Simpson (1945) and of Ellerman and Morrison-Scott (1951), but with modifications; for example, the carnivores are subdivided into two orders, the Fissipedia (terrestrial forms) and the Pinnipedia (amphibious forms). There appears to be some confusion in respect to the systematic position of *Tupaia*, a subject that has been much discussed. On p. 1,653 it states that G. G. Simpson (1945) recognizes six superfamilies in the Insectivora, of which the sixth is the Tupaioidea. In Simpson's well-known principles of classification (1945), however, he has eight superfamilies in the Insectivores—three fossil and five recent—and the Tupaioidea are not included. On the other hand, as is stated clearly and correctly on p. 1,646 and again on p. 1,855, Simpson places the Tupaiidae in the sub-order Prosimii of the Primates (a procedure with which the present work does not agree). In checking the references to *Tupaia* in the index, two pages are given, 1,722 and 1,969, on neither of which is this genus mentioned. Following general usage, *Oryctolagus* is separated from *Lepus* and *Panthera* from *Felis*; but, as a rule, as is advisable in a book of this nature, the specialist splitting of genera has not been widely followed, although the separation may be indicated by the newer name in brackets. In some groups, for example, the Rodentia, trinominal terminology is often employed.

As in former volumes, the illustrations form an important and valuable feature, and it is claimed that nearly three-quarters of the genera are illustrated. There are more than two thousand text-figures, about two hundred half-tones of photographs, three hundred half-tones of drawings, mostly wash, 1,580 line drawings, six reinforced by colour, and four full-page coloured plates. As might be expected with such a large number of illustrations, they are not all of the same quality, although the majority are excellent. The technique of the line-drawings for Figs. 349 and 380, for example, is not nearly so good as the general run and in particular such as Figs. 50 and 1,151, among many others. Fig. 1,711, a line-drawing reinforced with colour, is another excellent one. The half-tone of a photograph in Fig. 1,191 is quite poor. Most of the half-tone illustrations of drawings are good; but some, like Figs. 766 and 1,187, are outstanding. This question of the illustrations has been dealt with at some length because they have been stressed in the advertisements, and it costs no more to reproduce a good illustration than a bad one. Fig. 278 is upside down, and the legend of Fig. 1,984 states that it represents "mains droites" whereas they are left hands. In most of the figures of fossil forms the scale is given so that an idea of the size of the animal can be obtained; but it is a decided disadvantage that this is rarely done in the case of the living creature, so that, unless the reader is familiar with the genus, only a vague idea of the size is conveyed. Indeed, when more than one animal is depicted on the same page, no idea of the relative size can be obtained.

As in preceding volumes, experts have contributed the sections dealing with their own fields of study: in all, there are fourteen, including the editor, and they have been drawn from as far afield as Brussels, Dakar and Lisbon. This not only means authoritative treatment but also ensures that each part is up to date; this is shown by the inclusion of several references to papers published in 1955, the same year as the volume itself, and in the addenda is a brief account of ultrasonics and echo-location from the proofs of a paper that had not then appeared. After the treatment of each order, there is a valuable, selected bibliography.

Here, then, is a book that fills a noticeable gap in general zoological literature. Perhaps the nearest work, in English, with which it can be compared is Beddard's "Mammalia" in the Cambridge Natural History, which was published in 1909. The "Traité", however, is not only wider in scope but naturally deals with a much larger number of animals and brings home clearly the changes in outlook and knowledge that have occurred in the past half-century. There is no doubt that it will remain an indispensable work of reference for many years. C. H. O'Donoghue

## Petrographic Mineralogy

By Dr. Ernest E. Wahlstrom. Pp. vii+408. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 62*s*. net.

PROF. E. E. WAHLSTROM'S "Petrographic Mineralogy" is intended to bridge the gap which exists between text-books that explain the theory of the polarizing microscope and other instruments used in a petrographic laboratory, and those that describe the classification and properties of rocks and minerals.

The subjects dealt with in the first five chapters are the various petrographic methods and techniques that a student should know how to use, and they range from notes about the correct method of collecting and sampling rocks to detailed instructions for the use of the universal stage. The various optical, physical and chemical methods commonly used in the identification of minerals (excepting the goniometer) are all referred to, the emphasis being on identification in thin slice. The next two chapters describe the rock-forming minerals under two headings—silicates and non-silicates. Chapter 8 contains tables for the identification of minerals. The last three chapters deal with the composition, properties and classification of igneous, sedimentary and metamorphic rocks. All this matter is comprised within a book of rather less than four hundred pages, so that there is necessarily much compression; but the large number of explanatory line-diagrams and of photographic reproductions of rock-sections goes far towards compensation for this brevity.

This book is obviously designed to be placed in the hands of students after a preliminary term or two of instruction in the theory and use of the petrographic microscope. Such students, armed with this text-book, might then be expected to make good progress with a minimum of supervision—a great advantage, no doubt, in large classes. Used intelligently, and with aid of the references to further sources of information placed at the end of each chapter, it should fulfil the author's intention successfully.

## Soil Zoology

Proceedings of the University of Nottingham Second Easter School in Agricultural Science, 1955. Edited by D. Keith McE. Kevan. Pp. xiv+512+16 plates. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 55*s*.

THE study of the fauna of the soil has lagged far behind the study of its chemical and physical properties. The aim of the organizers of the second Easter school in agricultural science, held in Nottingham last year, was to direct attention to this deficiency. Those soil workers who had in the past neglected the fauna because they were unfamiliar with the methods of the zoologist had an opportunity at Nottingham to obtain instruction on the principles of animal identification and on various techniques, as well as hearing more specialized papers describing research on the soil fauna. This information is now made more widely available by the publication of the proceedings, edited by D. K. McE. Kevan.

There are contributions by workers from the Continent of Europe, including Kühnelt, Kubiena, Tischler, Haarløv, Overgaard Nielsen and Brauns, as well as workers in Britain. The contents are divided into two parts. Part 1, which occupies two-thirds of the volume, contains twenty-six papers on identification, general biology, ecology and applied aspects. Part 2 contains twenty-five papers describing methods of soil sampling, culturing, preserving and mounting animals, soil sectioning after impregnation with agar, and certain physiological techniques.

In an appendix, Mr. Kevan has included a useful key to the major groups of soil and litter animals. This key occupies thirty-six pages of small type and contains numerous line diagrams. There are a good general index, an author index, and indexes to the genera of animals and plants mentioned in the text.

L. H. FINLAYSON

## Introduction to Physical Geology

By Prof. Chester R. Longwell and Prof. Richard Foster Flint. Pp. x+432. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 40*s*. net.

IT might be expected that a book from the pens of two such experienced geologists and teachers as Profs. C. R. Longwell and R. F. Flint would be outstanding in quality, and this one does not disappoint. It develops the basic principles of the science by means of a careful examination of field evidence and also with the aid of a very large number of illustrations, including several instructive air photographs, many of which will be new to British readers. An important feature of the book is the care which has been taken to make these illustrations intelligible to the inexperienced readers for whom it is intended.

An unusual feature is the inclusion of brief references to the history of the subject, indicating to thoughtful readers that many of the conclusions which he tends to accept as axiomatic were only arrived at after much hard thought. The authors quote, for example, Shakespeare's lucid exposition of the cause of earthquakes, which expresses, not a playwright's fancy but a view held in his time and for centuries earlier.

The book embodies a wealth of experience, principally that of its authors, but also that of many others whom they consulted while writing it. It will prove a very useful addition to the departmental libraries in universities, and in schools in which geology is taught.

## Discoveries and Inventions of the 20th Century

By J. G. Crowther. Fourth edition, entirely revised and rewritten. Pp. xvii+432+64 plates. (London: Routledge and Kegan Paul, Ltd., 1955.) 30*s*. net.

ALTHOUGH this fourth edition has been entirely revised and rewritten, Mr. J. G. Crowther has retained the general form of the third edition. Some chapter headings have been changed and much new material incorporated, covering inventions and developments of the past twenty-five years. Whether this is now quite appropriate is a matter of opinion; but the treatment of plastics appears to have been prejudiced by the arrangement, and in this edition is quite inadequate. Something should have been included on the advances in medicinals during this period, if only because of the far-reaching effects of the control of malaria, trypanosomiasis and other killing diseases.

Criticism of omissions, however, is invidious and, apart from these two features, the book gives a comprehensive and readable picture of the discoveries and inventions of the past fifty years. Of minor slips, attribution of the invention of chromatography solely to Tswett instead of to Runge and others may be mentioned.

R. B.

# THE GEORGE R. AGASSIZ RADIO TELESCOPE OF HARVARD OBSERVATORY

By Prof. BART J. BOK
Harvard College Observatory

ON April 28, two hundred staff members and guests gathered at Harvard Observatory's Agassiz Station in the town of Harvard, Massachusetts, to assist in the dedication of the 60-ft. radio telescope that carries the name of Harvard Observatory's long-time benefactor, the late George R. Agassiz (1862–1951). It was fitting that Dr. Alan T. Waterman, director of the National Science Foundation, should have officiated at the dedication, since the Foundation, with further assistance from friends of the Agassiz Station and from the Research Corporation of New York, had provided the funds for the construction of the new radio telescope.

## The Antenna and its Mounting

The 60-ft. instrument was built by D. S. Kennedy and Co., of Cohasset, Mass. Its antenna is a paraboloid of expanded aluminium wire-mesh, each square of the mesh measuring $\frac{3}{8}$ in. on a side; tests by the Kennedy engineers indicate that the antenna surface is a true paraboloid to within $\frac{1}{4}$ in. A horn-feed at the focus collects the radiation received by the antenna.

The mounting of the antenna is of equatorial design and the telescope is motor-driven. Preliminary purely mechanical adjustment produced a position for the polar axis of the instrument to within a fraction of a degree of the true pole, and final adjustment by the usual optical techniques has now been completed. The setting and following accuracy of the instrument required by contract is of the order of ten minutes of arc; the manufacturers have provided for even greater precision of setting and following, with maximum uncertainties in either co-ordinate apparently no greater than two or three minutes of arc. The instrument will be used initially for research at the wave-length of the neutral hydrogen line at 21 cm.; at this wave-length the angular resolution of the Agassiz radio telescope is of the order of seven-tenths of a degree, so that the setting and following accuracy that is attainable with the instrument are more than sufficient for research on discrete radio sources.

One feature of the mounting that is especially worth mentioning is the polar axis of the instrument, which is in essence a single roller bearing with a diameter of 7 ft. The shortness of the polar axis permits the pointing of the antenna to any direction above the horizon.

## The Electronic Equipment

The electronic equipment was constructed by the Ewen-Knight Corporation, of Needham, Mass., and it has been designed primarily for research dealing with the radio radiation of wave-length 21 cm. emitted by neutral, atomic hydrogen in interstellar space. The 21-cm. lines received on the Earth from most directions in the sky are widened considerably in frequency caused by the rotation of our galaxy. At the frequency of 1,420 Mc./sec., corresponding to the wave-length of 21 cm., the line-widths produced by galactic rotation alone amount often to as much as 2 Mc./sec. We note here that a radial velocity shift of 1 km./sec. at a frequency of 1,420 Mc./sec. amounts to a frequency shift of very nearly 5 kc./sec. Random turbulent velocities of the hydrogen clouds of our galaxy also contribute to the observed shapes of the hydrogen-line profiles. In all of the research to date at the Agassiz Station, special emphasis has been placed upon high resolution in frequency. For the research of the past three years with the 24-ft. steerable paraboloid, we have used apparatus with a frequency band-width of 15 kc./sec., equivalent to a resolution of 3 km./sec. in radial velocity. The new equipment is designed for primary operation with a band-width in frequency of 5 kc./sec., or an equivalent resolution of 1 km./sec. in radial velocity. The new electronic equipment has been designed by Harold I. Ewen, who, with the present writer, has from the start been the co-director of the Agassiz Station Radio Astronomy Project. The instrument has been described as follows by its designer:

The receiver is a microwave double-conversion superheterodyne comparison radiometer. Comparison is achieved by 400 c./sec. switching of the first local oscillator between two frequencies spaced 2 Mc./sec. apart. As a result, the receiver compares 'signal-band' information to a signal-free 'noise-band' at a rate more rapid than normal gain fluctuations. By this means the effect of receiver-gain fluctuations is considerably reduced at the receiver output.

The Model 1044 radiometer incorporates some rather fundamental changes in the normal design for equipments of this type. A significant departure from the more conventional approach is the double-bank 20-channel comb filter at the second conversion frequency.

The twenty filters each have a band-width of 5 kc./sec. and are spaced 100 kc./sec. apart to cover a complete 2 Mc./sec. band. Their effect is the same as twenty receivers operating in parallel, each tuned 100 kc./sec. from the one on either side.

For a particular tuned frequency, all channels operate simultaneously and store their individual information in integration networks. The charging time or integration time of these twenty networks is 110 sec. At the end of the charging time, the integrated information is 'read out' from each channel, in sequence, by an analogue to digital computer, and recorded by an electric typewriter as the first row of twenty numbers in a 2 Mc./sec. scanning sequence. The second local oscillator is then 'step-tuned' 5 kc./sec., which effectively moves each of the twenty channels 5 kc./sec. higher in information-response frequency. The integration sequence is repeated and recorded by the typewriter as the second row of twenty numbers in the 2 Mc./sec. scan. This sequence is repeated twenty times until the typewriter output consists of twenty rows of numbers arranged in twenty columns.

The first column of twenty numbers represents the first 100 kc./sec. of the desired 2 Mc./sec. of information. The second column covers the range 100 kc./sec.

[Photograph by Robert E. Cox

Fig. 1. The 60-ft. George R. Agassiz Radio Telescope, Harvard Observatory

to 200 kc./sec., etc. Each of the four hundred numbers typed represents the average hydrogen temperature above background as measured in an individual 5 kc./sec. frequency-band. The entire 2 Mc./sec. scan is accomplished in 40 min., as compared to single-channel operation requiring 13 hr. 20 min.

## Programme of Research and Training

From its initiation, the Agassiz Station project in radio astronomy has had the dual aim of training graduate students and of advancing research in the field. The completion and putting into operation of the 60-ft. radio telescope should serve to strengthen both parts of the programme, since the project will in all likelihood remain one operated primarily for and by graduate students in radio astronomy. Such a policy is in line with that of the National Science Foundation, the organization that has thus far borne a little more than half the expense of operating the project. However, the planning of research and the granting of permission for guest observers to use the equipment will now become more flexible, since we shall have available both the 24-ft. and the 60-ft. radio telescopes. The future may, therefore, well see a considerable extension of the programme outlined below.

The Harvard programme to date has been primarily concerned with astrophysical studies of 21-cm. radiation relating to interstellar neutral, atomic hydrogen. One of the first results with the 24-ft. radio telescope was the discovery by Lilley[1] of excessive concentration of neutral atomic hydrogen in the Taurus Complex of dark nebulosity, which led to the conclusion that the average ratio of densities of gas to dust in the large dust complexes is about 100 : 1. This ratio appears not to be constant as we proceed to the smaller dust units; but obviously the search for and study of small-scale concentrations of neutral atomic hydrogen associated with dark nebulæ presents an important problem for the new instrument with its high angular resolution.

Lawrence[2] and Heeschen and Drake[3], working with the same instrument, have already done some interesting work relating to the fine structure of the interstellar hydrogen medium. Lawrence has studied certain regions near stars for which Münch, at Mount Wilson and Palomar Observatories, had found optical evidence for multiple interstellar lines. Two interesting cases of coincidence between optical and 21-cm. wave-length radial velocities have already been found; the availability of the 60-ft. radio telescope with its high angular resolution and the improved resolution in frequency of the electronic apparatus holds great promise for future research in this field. Heeschen and Drake studied the 21-cm. wave-length radiation in the Pleiades cluster, and here they found evidence for a double-peaked 21-cm. profile, with one component coinciding in radial velocity almost precisely with that of the Pleiades cluster of stars, the other with that of the optical interstellar absorption lines. The completion of the 60-ft. radio telescope makes it profitable to examine the 21-cm. wave-length radiation from many clusters of stars, from associations and aggregates, and from certain diffuse nebulæ and the regions surrounding them. The researches by Menon[4] of the Orion Complex illustrate how much we can learn from a detailed survey on a wave-length of 21 cm. of a section rich in *O* and *B* stars, emission and reflexion nebulosity and cosmic dust. Similar work can now be attempted for smaller sections of special interest. Among regions of the sky that will be receiving special attention with the new equipment are the clusters and associations *NGC* 2244 and 2264 (Menon) and the region of λ Orionis (Campbell M. Wade).

One of the most important fields of research on the 21-cm. wave-length is the study of the spiral structure of our galaxy—a field in which the Dutch and Australian astronomers have excelled. At the Agassiz Station, we have in this area concentrated on investigating in detail a few sections of special interest, stressing at all times the close interrelation that exists between optical and radio research. To date, the principal effort has been for galactic longitudes $l = 60°$ to 135°, for which we have some results by Matthews[5] and by Davis (unpublished). These researches reveal an amazing degree of fine structure in the portions of the three major spiral arms that are observed in this section. There are several instances of apparent bifurcation, and it is most striking how certain apparently minor features may be traced over a considerable range of galactic longitude and latitude. Matthews and Davis especially directed attention to the great mass of the neutral atomic hydrogen associated with the Perseus arm as compared to the Orion arm—a surprising result in view of the greater distance of the Perseus arm from the centre of our galaxy. With the new equipment we hope to extend these studies with point-to-point analyses for the detailed structure near positions of

critical importance from the radio or optical point of view. In addition to the section $l = 60°$ to 135°, we are concentrating on the region of the Cygnus cloud (Mrs. May Kassim), and in the section $l = 335°$ to $l = 15°$ for which Howard and Heeschen[6] have already reported preliminary results.

The study of the absorption features in the 21-cm. wave-length profiles for regions centred upon discrete radio sources is not practicable with our 24-ft. antenna, but it has already been demonstrated by a brilliant investigation at the Naval Research Laboratory in Washington, D.C., that this is an exceedingly profitable research field for radio telescopes of 50-ft. aperture and greater. We plan initially to concentrate on this type of research with the 60-ft. George R. Agassiz radio telescope. The narrow band-width and accompanying high resolution in frequency of Dr. Ewen's equipment will prove invaluable for studies at 21-cm. wave-length of discrete sources and the regions near them.

At the time of the dedication of the Agassiz radio telescope, Dr. Heeschen announced the discovery of 21-cm. radiation from the direction of the Coma Cluster of galaxies at a distance of approximately 75,000,000 light years from the Sun. The shift in frequency of the 21-cm. wave-length feature indicated a recessional radial velocity for the atomic hydrogen in good agreement with the radial velocity of recession found optically for the galaxies in the Coma Cluster. The dispersion in radial velocity suggested by the radio observations is comparable with, though slightly less than, the value found from the optical evidence. Heeschen's results were obtained with the 24-ft. paraboloid. The 60-ft. telescope will assist in localizing the source or sources of radiation of 21-cm. wave-length in the Coma Cluster of galaxies, and with the new equipment several other clusters of galaxies come within reach.

The results of research with radio telescopes of apertures between 24 and 50 ft. have shown already that the 21-cm. wave-length field is a rich one for future research with radio telescopes of larger aperture, especially when the results of optical and radio studies are brought to bear upon the solution of any given problem. For the present we have limited ourselves largely to research in our own galaxy; but already it is obvious that radio telescopes with apertures of 60 ft. and greater have important contributions to make in the study of 21-cm. wave-length radiation from other galaxies and from intergalactic space.

A 60-ft. radio telescope with a precision paraboloid antenna is a versatile instrument and can be used effectively for studies at wave-lengths other than 21 cm. It would be presumptuous to suggest at this time the uses to which the Agassiz radio telescope may be put in the years to come. There are, however, two areas of research in which the instrument is expected to make some contribution in the not too distant future. One is the study of the continuum near 21 cm. wave-length and possibly at other wave-lengths in the range 10–50 cm. The other is in the search for other line emission or absorption features, notably in an attempt to find evidence for the presence of OH at a wave-length near 18 cm. (frequency approximately 1,667 Mc./sec.).

To describe the future programme of a 60-ft. radio telescope is really a very difficult task. For, as radio astronomy is coming of age, it takes its place—along with photoelectric photometry and spectrography—as one of the basic techniques for the study of the physical universe. A 60-ft. radio paraboloid may in the future have as many roles as have in the past the 60-in. reflectors for optical studies of our Milky Way System and other galaxies.


[1] Lilley, A. E., *Astrophys. J.*, **121**, 559 (1955).
[2] Lawrence, R. S., *Astrophys. J.*, **123**, 30 (1956).
[3] Heeschen, D. S., and Drake, F. D., *Astron. J.*, **61**, 5 (1956).
[4] Menon, T. K., doctoral dissertation, Harvard (1956); see also paper presented at Jodrell Bank Symposium, 1955 (in the press).
[5] Matthews, T. A., doctoral dissertation, Harvard (1956); see also *Pub. Astro. Soc. Pacific*, **67**, 112 (1955), and paper presented at Jodrell Bank Symposium, 1955 (in the press).
[6] Howard, III, W. E., and Heeschen, D. S., *Astron. J.*, **61**, 6 (1956).


# THE GOUGH ISLAND SCIENTIFIC SURVEY, 1955–56

By M. W. HOLDGATE, R. W. LeMAITRE, M. K. SWALES and N. M. WACE

THE background and personnel of the Gough Island Scientific Survey, which has recently returned to Britain, and the little that was known about Gough Island prior to its visit, have been described in an earlier article[1]. The expedition left England in September 1955 and landed on Tristan da Cunha on October 1. During a six-week stay there, the vegetation, agriculture and bird-life were studied in detail, and some rock specimens and invertebrate animals were collected. Peat samples for subsequent pollen analysis were obtained from a lowland and an upland bog.

On November 13, 1955, a landing was made on Gough Island. This island lies on the central Atlantic ridge, some 230 miles south-south-east from Tristan, the centre of the island being about 40° 17′ S. and 9° 56′ W. It is about eight miles long and four miles wide, and, like Tristan, is more than 1,500 miles distant from the nearest continent.

Within a few minutes of landing, the Expedition's leader, Mr. R. J. H. Chambers, collapsed with a back injury which necessitated his evacuation three days later. He was succeeded by Dr. M. W. Holdgate. A sectional wooden hut was erected near the landing place, as a base, and after paths had been cut through the forest to facilitate access to the high ground, two tented camps were established on the mountains. The exploration of the island was carried out from these camps, and also from Base, using a dinghy. The Tristan islanders, of whom two pairs were at different times employed by the expedition, proved especially skilled at handling a boat, and landings were made on all except the west coast of Gough.

In February 1956, Mr. J. B. Heaney, the organizer and original leader and surveyor of the expedition, joined the party and became joint-leader with Dr. Holdgate. The expedition was relieved by the South

African frigate *Transvaal* on May 13, 1956. The installations were taken over by the South African Weather Bureau, which will continue the meteorological station on Gough until the end of the International Geophysical Year.

## Topography and Survey

Mr. J. B. Heaney, assisted by Dr. M. W. Holdgate and other members of the expedition, surveyed the island on a scale of 1/30,000. A triangulation scheme involving twenty-five stations provided a network of fixed points including the main peaks and many coastal features. The baseline, 1,860 ft. in length, was measured on a plateau 2,000 ft. above sea-level in the centre of the island. The latitude and longitude of a trigonometrical station near the hut was determined from position-line observations on sixteen stars. The detailed survey was carried out using a plane table on which rays were plotted to a large number of features. An 80-cm. rangefinder was used for measuring distances, and the vertical angles from a clinometer enabled these to be corrected to the horizontal in the field. A dense control of spot heights was established, and contours at an interval of 250 ft. were interpolated.

The centre of the island proved to be an undulating plateau some 2,000 ft. above the sea. The highest peaks rise 500–1,000 ft. above this (the summit of the island being provisionally fixed at 2,995 ft.). Peat bogs cover the plateau, but in the north there are extensive areas of bare rock. Along the north and east sides, eight deep valleys cut back into the plateau; these are 1–1½ miles long and are separated by narrow, craggy ridges. On the west the plateau slopes more evenly to the top of the sea cliffs, which, though nowhere sheer, are up to 1,500 ft. high. In the south there is a strip of level lowland about half a mile wide, between the mountains and the sea. Most of the island is surrounded by cliffs, and there is only one landing place which gives easy access to the interior.

## Meteorology

A meteorological station was established at Base, 20 ft. above sea-level, and operated continuously from November 20, 1955. The instruments were provided by the South African Weather Bureau, which seconded Mr. J. J. van der Merwe to the expedition as meteorologist.

During the five months December–April inclusive, the mean monthly noon temperatures were 15·2, 14·6, 15·4, 13·9 and 13·7° C., respectively. The highest maximum temperature during the period was 23·7° C. (on February 17) and the lowest minimum 5·5° C. (January 25). The rainfall totals for the five months were 197·7 mm., 304·5 mm., 152·2 mm., 101·0 mm. and 261·9 mm., while the mean daily sunshine figures were 5·4, 5·5, 4·7, 3·2 and 1·8 hr., respectively. The climate was oceanic, and was dominated by a succession of warm and cold front systems.

Orographic cloud was frequent over the island, and standing-wave cloud systems often formed in the lee. Some photographs and notes of these were obtained.

A few tidal readings, on a graduated pole, indicated a mean tide-range of about 3 ft., increasing to 3 ft. 6 in. at springs.

## Geology

By R. W. LeMaitre, St. John's College, Cambridge

More than two hundred rock specimens were collected from a large number of localities on the island. These will be worked up in the Department of Mineralogy and Petrology at Cambridge, and it is hoped to publish an account of their petrology in the near future.

In the field it was possible to distinguish four main phases in the structure of the island: (1) an extrusive phase of basalts with minor tuffs, later invaded by dykes; (2) an extrusive phase of trachytes, mainly in the west of the island, preceded by an explosion forming thick local deposits of tuff; (3) another extrusive phase of basalts overlying the two earlier phases; (4) an intrusive phase of trachyte laccoliths and plugs. It is hoped that some of the trachytes will be dated by the radioactive potassium/argon ratio, and that some palæomagnetic work will be possible with the aid of some orientated specimens.

## Botany

By N. M. Wace, Department of Botany, The Queen's University, Belfast

No systematic work having been possible during the three previous brief visits of botanists to Gough Island[2–4], collection and description were the first botanical tasks of the expedition. Studies were also made on the dispersal mechanisms and reproductive methods of the vascular plants.

Collections immediately revealed that the number of species is extremely small, the provisional number recognized in the field being thirty-eight angiosperms (of which six are probably human introductions), twenty-five pteridophytes, and about a hundred bryophytes. Freshwater and marine algae, lichens and fungi were also collected. The first set of all the collections will be presented to the British Museum (Natural History).

Studies on the vascular plants emphasized the widespread reliance upon wind as an agent of dispersal and pollination, the almost complete absence of annuals among the native plants, and the general dependence upon vegetative, rather than sexual, reproduction.

Blanket peat covers almost the entire island. Below about 300 m. (1,000 ft.), to the east and south, this supports a dense forest in which a mosaic of communities dominated by *Phylica arborea*, *Blechnum tabulare* and *Histiopteris incisa* are the most important components. At a similar altitudinal range on the western cliff-slopes, tussock-grasses form an almost pure community on dry, stable peat. Above the forest and tussock associations, and up to 450 m. (1,500 ft.), a variety of species, notably *Empetrum rubrum*, *Acaena* spp. and *Apium goughensis*, are the most important dominants in a zone of upland peats. From 450 m. to the highest points in the island (about 900 m.), a zone of thin wet alpine peats dominated by small species of *Agrostis* and *Scirpus*, with numerous bryophytes, covers all but the most exposed rock. Valley bog communities, dominated by *Sphagnum* spp. and other bog bryophytes, occur in all the mountain valleys and on the plateaux above 450 m.

Some descriptive work was also done on the marine algal communities, in which a littoral zonation was very marked despite a mean tide-range of only 0·8 m. (3 ft.). A sub-littoral zone of *Macrocystis* sp.

occurs around much of the east (prevailing lee) side of the island.

Two peat sites were investigated by boring in Tristan and one on Gough Island. Stratigraphical and sampled bores were made in all three sites, and samples also obtained for radiocarbon dating. No definite signs of glaciation were seen on either of the islands, but some evidence of fluctuation in sea-level was noted on Gough Island.

### Invertebrate Zoology

By M. W. Holdgate, Queens' College, Cambridge

About three thousand invertebrate specimens were collected during the six months on Gough Island, despite the fact that the author spent half his time in surveying. The sixty-seven main collecting stations were distributed to sample all the chief plant associations, over a wide altitudinal range. Some collections from similar types of vegetation were made on Tristan for comparison. On Gough, some freshwater localites were also sampled, and a study made of the littoral fauna of a typical 200-yd. stretch of rocky shore.

The terrestrial invertebrate fauna of Gough proved to be very poor and it is unlikely that more than a hundred and fifty species in all were collected. Many of the species that do occur are, however, very abundant and occupy a wide range of habitats. A few of the insects proved to be apterous or brachypterous, the most striking example of this condition occurring in an upland Lepidopteran superficially resembling the endemic *Dimorphinoctua cunhaensis* of Tristan[5]. It is likely that many of the species collected will prove to be endemic.

The littoral fauna was somewhat richer in species, and despite the small tide-range showed some zonation.

### Vertebrate Zoology

By M. K. Swales, Magdalene College, Cambridge

Twenty species of 'sea birds', mostly of the order Procellariiformes, and none of them new records, were found to occur on Gough Island. Of these, seventeen species were shown to be nesting, some of them in great abundance. More than a thousand of these birds, including some of all species, were weighed and measured. A study was made of the wandering albatross (*Diomedea exulans dabbenena*), a subspecies almost confined in its breeding distribution to Gough Island. The two endemic species of land birds occurred commonly throughout the island and a special study was made of these. The bunting was found to be one species only (*Rowettia g. goughensis*) with five well-marked plumage stages, the youngest a speckled dark brown and the adults green in colour. The rail (*Porphyriornis c. comeri*) has distinct juvenile and adult plumages only (brown and black, respectively). Some live specimens of both species were brought back to England for further study.

More than 10,000 fur seals (*Arctocephalus pusillus*) were counted on the island's beaches. They are most abundant on the west coast, which is more storm-beaten and less accessible than the east coast. Estimates were also made of the composition of the herds. The numbers of seals available for exploitation will be calculated from these figures.

A census was made of the elephant seals (*Mirounga leonina*) on the island. The total population is less than three hundred. In contrast to the fur seals, these are found mainly on the east coast on pebble and sand beaches.

Detailed accounts of the expedition's results in these fields of study will appear in the appropriate journals in due course.

We are most deeply grateful to H.R.H. the Duke of Edinburgh for his interest in the expedition and the support he has given it. We would also like to thank the Scott Polar Research Institute, the Royal Geographical Society, and all those other departments, societies, colleges, firms and individuals without whose aid the expedition could not have taken place.

[1] Heaney, J. B., *Nature*, **176**, 575 (1955).
[3] Christophersen, E., Scientific Results, Norwegian Antarctic Expedition 1927–28, No. 13 (1937).
[2] Rudmose Brown, R. N., *J. Linn. Soc. (Bot.)*, **37**, 238 (1905).
[4] Wilkins, H., *J. Bot.*, **63**, 65 (1925).
[5] Viette, P. E. L., Scientific Results, Norwegian Expedition to Tristan da Cunha, No. 23 (1952).

## NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE

It is no new idea that most of the advances in the techniques of chemistry have come from the use of apparatus and methods originally devised by physicists. This is particularly true of spectroscopy, where the main applications associated with the different frequency bands have moved over, one after another, from the pure physicist to the chemist. As a result, ultra-violet and infra-red spectroscopy are now considered as subjects belonging to physical chemistry, and even γ-ray spectroscopy is finding considerable application in chemical research.

It would appear that during the past eighteen months a similar move has been taking place with the two new techniques of nuclear magnetic resonance and electron spin resonance. Both these subjects originated in the physics laboratories, and for several years after their initial discovery were applied to purely physical problems such as the determination of nuclear spins and moments. As with all techniques which study the interaction of atoms with external forces, it soon became clear that these new methods also had very great potentialities as tools for chemical investigation, and during the past few years these applications have been brought to light in a very striking way.

The increasing interest among chemists concerning the possible uses of these techniques was reflected by the decision of the Physical Methods Group of the Society for Analytical Chemistry and the Photoelectric Spectrometry Group to hold a joint meeting on the subject in Oxford on May 25. This meeting was timely, as it would appear that there are now quite a large number of chemists in Great Britain who are already aware that a new tool has become

available, but many are not yet clear as to the precise applications and limitations of the new techniques. The meeting was divided into two sections with two speakers presenting papers on nuclear magnetic resonance and two presenting papers on electron spin resonance; in this way the apparatus and applications of each technique were brought clearly to light. This careful differentiation was found to be very necessary, as some confusion appears to exist between the two subjects. It was for this reason that the name 'electron spin resonance' was used to describe the resonance absorption associated with electronic transitions, instead of 'paramagnetic resonance'. Although the latter title has been widely used in the past few years, it can, in principle, be equally well applied to nuclear resonance absorption, and hence in order to avoid any confusion it was suggested that it would be wise to use the distinguishing titles of 'nuclear magnetic resonance' and 'electron spin resonance' in future chemical work.

Dr. R. Richards (University of Oxford) presented the opening paper introducing the general theory of nuclear magnetic resonance, and then outlining some of its main applications. He explained how nuclear resonance absorption can be obtained if a strong magnetic field is applied across a specimen containing nuclei with magnetic moments. These will then take up different quantized orientations in the magnetic field and, if radiation is fed to the specimen with a frequency such that $h\nu$ is equal to the energy difference between the quantized states, a resonance absorption will occur, which can be detected by a fall in the radiation transmitted through the system. For hydrogen nuclei in a typical field of ten thousand gauss, this resonant absorption will take place at a frequency of 42·6 Mc./s., and hence all the techniques associated with normal radio and television frequencies are used for generating and detecting the radiation. There are two great advantages of spectroscopy at these frequencies; the first is that line widths from liquid samples are extremely small, corresponding to 1 c./s. or $10^{-11}$ cm.$^{-1}$, and the second is that the frequencies of absorption can be measured with very high accuracy by normal radio techniques. As a result it is possible to determine nuclear gyromagnetic ratios and magnetic moments with very great precision, and it was soon found that the small changes in magnetic field produced by different electron configurations around the nuclei could be detected and differentiated. In this way it is possible not only to distinguish different elements and isotopes present in a compound, but also to differentiate between different groupings of the same element. The proton resonance of ethyl alcohol was shown as an example, as in this case the absorption is split into three main lines, one corresponding to the hydrogens of the $CH_3$ group, one to those of the $CH_2$ group and the other to those of the OH group. The occurrence of this 'chemical shift' often enables a detailed chemical analysis to be made, the whole operation only taking a few minutes. Several well-illustrated examples of this high-resolution work were given as applied to hydrogen, fluorine and phosphorus chemistry. It was also shown how a further splitting of the lines gives information on the positions of groups relative to each other, and hence structural as well as group analysis is thus possible.

Dr. M. Packard (Varian Associates, U.S.A.) then showed a series of slides giving details of the experimental techniques involved in high-resolution nuclear magnetic resonance, and illustrating some of the spectra actually obtained. The way in which the fine detail of the lines could be used to differentiate between various structural formulæ of the same compound was ably demonstrated, and in some cases it was even possible to distinguish excited triplet states. This high-resolution work requires a large and very well stabilized magnet, however, such that the field can be maintained homogeneous to 1 part in $10^8$, and it is the cost of such equipment that is the main limitation on this work at the moment.

Dr. E. E. Schneider (University of Durham) then read a paper introducing the theory and technique of electron spin resonance, comparing and contrasting it with nuclear resonance. In electron spin resonance, the applied magnetic field acts on the magnetic moments associated with the unpaired electron spins, and since these moments are about a thousand times greater than those of the nuclei the resulting energy-level splittings, and hence frequencies of absorption, are correspondingly increased. Electron resonance absorption in a field of ten thousand gauss therefore occurs at about 30,000 Mc./s., and all the radio-frequency circuits of nuclear resonance are replaced by waveguides and other radar techniques. There is one great advantage in working at these high frequencies, namely, that the sensitivity of the technique is very much increased. The net absorption that is actually measured in either nuclear or electron resonance is the difference between the energy absorbed by the electrons or nuclei in the ground-state and the energy emitted from those in the excited state. This difference depends on the ratio of the numbers in the ground and excited states and will become larger the greater the energy splitting between the levels and the lower the temperature of the specimen. As a result of the much larger energy splitting associated with the electronic spin changes, the sensitivity is very much greater than that for nuclear resonance; and whereas protons can only be detected down to $10^{16}$ per gm., it is possible to detect and measure the concentrations of unpaired electrons down to $10^{12}$ per gm., or $10^{-11}$ molar. It is this feature of high sensitivity which offers most promise in the chemical applications of electron spin resonance, as although it cannot compete with the general high resolution of nuclear resonance, it can measure trace paramagnetic constituents to far greater dilutions.

Dr. D. J. E. Ingram (University of Southampton) then presented a paper dealing with more specific and particular applications of electron spin resonance. The systems to which the techniques can be most readily applied are those containing stable unpaired electrons such as normal paramagnetic atoms and organic free radicals. It is possible, however, to obtain atoms or molecules which have been left with an unpaired electron as a result of irradiation or some similar process. Such atoms or radicals can then be studied by the normal techniques of electron resonance and detailed chemical information often obtained. Illustrations of some such systems were then given, including radicals formed by ultra-violet irradiation and then trapped in low-temperature glasses, and others formed by X- or $\gamma$-ray irradiation. In these cases, as with all electron resonance spectra, considerable information can often be obtained from the hyperfine splitting of the lines which arises from an interaction with the magnetic moments of the neighbouring nuclei. The distinctive hyperfine structure produced by different elements can also be used in such practical applications as measuring the con-

centrations of impurity atoms in semiconducting material. Other applications were also mentioned, such as following the progress of chemical reactions which proceed via a transient intermediate, and also the detailed structural information that can often be determined from the angular variation of the spectra in single crystals.

The discussion which followed the main papers was opened by Drs. D. H. Whiffen, C. A. Parker and D. J. Ferrett. One of the main questions raised was that of absolute calibration and reproducibility of results. It was suggested that the most accurate form of quantitative measurement was by comparison with the signal from a small amount of a standard sample placed in the same radio-frequency field. For work with free radicals, the use of auxiliary coils to increase the field around the standard specimen was mentioned, although the more general technique employing a substance such as ultramarine, which has its resonance slightly displaced from the free-electron value, is probably to be preferred. The applications of the relatively less expensive low-resolution nuclear resonance were also described since, although this cannot give the group analysis of the high-resolution work, it can be applied to quantitative determinations of isotope concentrations for more than a hundred different nuclei.

It would appear that there are in fact three distinct types of resonance spectroscope that should be of considerable use to the chemist. The first is that employing very high-resolution nuclear magnetic resonance. This can not only distinguish different isotopes but also differentiate between various groups and bond-types of the same element, and thus provide a detailed structural analysis from a few grams of liquid. The disadvantage of this type of apparatus is purely practical, as a twelve-inch diameter magnet with a very homogeneous field is required, at a cost of several thousands of pounds. If detailed chemical information is not required, however, and only a quantitative determination of the different elements present is needed, then low-resolution nuclear resonance is quite sufficient, and relatively inexpensive magnets can be used. It is also easier to apply more sensitive means of detection to the low-resolution apparatus, and concentrations down to $10^{16}$ protons per gm. can be measured.

As distinct from both of these, an electron-resonance spectroscope can be used wherever unpaired electrons occur in a chemical system. The sensitivity is very much greater than that of nuclear resonance, and the less expensive magnets can be employed. It should therefore prove a powerful and readily available tool for investigating such systems down to dilutions of $10^{-11}$ molar. It would appear that the main applications of this technique are going to be in the fields of free-radical and irradiation chemistry, and it will probably find as much use in the medical and biological sciences as in physical chemistry.

D. J. E. Ingram

# OBITUARY

## Mr. E. B. Wedmore, C.B.E.

The name of Mr. E. B. Wedmore, whose death occurred at the age of eighty years on June 16, is widely known in two very different spheres. He was in a very real sense a pioneer in the development of research associations, and he was an apiarist of great repute. Mr. Wedmore can properly be described as the architect of the structure of the British Electrical and Allied Industries Research Association (E.R.A.), which is one of the largest co-operative research organizations in Great Britain at the present time.

Born at Bristol in 1876, Wedmore received his early education at private schools. His first scientific education at the University College of Bristol was followed by a short course in civil engineering at the Finsbury Technical College, and then by the full course in electrical engineering at that College.

He joined the Bristol Corporation Electricity Works in 1895 as an assistant, but returned to Finsbury Technical College during 1896–99 as a lecturer and demonstrator, gaining the City and Guilds Silver Medal in 1896. During 1899–1919 he was design engineer with the British Thomson-Houston Co., Ltd., in London and Rugby, and during this time he took out a number of patents, mainly for switchgear.

A shortage of certain materials essential to the electrical industry arose in 1917 as a result of submarine warfare, and in order to foster the devising of means to minimize the effects of this shortage, an Electrical Research Committee (E.R.C.) was set up under the ægis of the British Electrical and Allied Manufacturers' Association and the Institution of Electrical Engineers; this was the forerunner of the British Electrical and Allied Industries Research Association. Mr. Wedmore was appointed director of the earlier body in 1919, and he became director and secretary of its successor upon the incorporation of that body in 1920. This post he held up to the time of his retirement at the end of 1944. In 1938 he was appointed C.B.E. in recognition of his services.

Wedmore's qualities of character and mind proved to be admirably suited to the task of building up and developing the young research association. He was a good judge of men and quickly gathered about him a group of able engineers and scientists. Scientific judgment and inventiveness he possessed himself in a high degree, and he had an inspiring fertility of mind. With all these qualities was coupled an extraordinary business acumen.

Wedmore's own field of scientific interest was wide; it accommodated such diverse topics as colour photography and the making of models of four-dimensional 'objects' as seen in three-dimensional space. His major contributions were to the art of circuit breaking and to improvements in switchgear. Crucial observations of some of the basic phenomena of circuit breaking were made with a simple high-speed camera devised by Wedmore, and as an outcome of these experiments came the invention, jointly with Dr. Whitney, of the air-blast circuit breaker and of the oil-baffle switch. Wedmore was active in the field of international standardization, and was a member of a number of committees of the International Electro-Technical Commission. He attended the first meeting of the Conférence International des Grands Réseaux Électrique, which was held in Paris in 1921, and he was largely responsible

for the establishment of the liaison committee of that conference, from which developed the present British National Committee.

Wedmore communicated a number of papers to the Institution of Electrical Engineers and he was awarded several of the major premiums of the Institution, namely, the John Hopkinson in 1915, the Institution Premium in 1918, and the Kelvin in 1929.

Wedmore was reticent in nature and somewhat austere in appearance. He was, however, under the surface, very human and generous and sympathetic to any in real trouble, and he had a deep sense of loyalty to colleagues. It is a tribute to Wedmore's insight and ability that he should have built up, as a pioneer, a successful co-operative research organization with little to guide him other than his own shrewd judgment and initiative. J. GREIG

---

THE death of Mr. E. B. Wedmore has removed a well-known and greatly respected personality from bee-keeping circles. Despite his heavy professional responsibilities when director of the British Electrical and Allied Industries Research Association, Mr. Wedmore managed to find time to practise bee-keeping, to which he applied his scientific training and research experience. Since his retirement a few years ago, beekeeping research had occupied an increasing proportion of his time and he was always eager to discuss new results and ideas and to help beekeepers and research workers in any way that he could.

In 1944 the Beekeeping Standards Committee of the British Standards Institution was formed, and Mr. Wedmore was the natural choice for its first chairman, a position he held with great distinction until his death. He also served on other committees of the Institution which dealt with the standardization of honey tins, honey jars, etc.

For many years Mr. Wedmore was a member of the Apis Club, several county beekeepers' associations and of the British Beekeepers' Association, of which he was president in 1946. He was, for some time, chairman of the Research Committee of the British Beekeepers' Association, and was an active member of the Council of the Bee Research Association since its formation in 1949. He was responsible for a number of the Association's researches which were carried out with the co-operation of beekeepers, notably on methods of management of colonies and on queen introduction.

He was also interested in establishing better standards for honey in Britain, and his re-examination of earlier work on the chemical and physical properties of honey led to new tables relating refractive index to water content. Further papers on the accurate determination of the water content of honeys were in preparation at the time of his death.

Mr. Wedmore's books, "A Manual of Beekeeping" and "The Ventilation of Bee-Hives", together with his booklet, "Successful Bee-keeping", will undoubtedly continue to be used by beekeepers for many years to come.

Although rather shy and reserved, Mr. Wedmore gave much time to helping other beekeepers by lecturing and in other ways. His lectures contained a great deal of original, constructive thought. He was always willing to reconsider his own views in the light of new work and was foremost in efforts to encourage beekeepers to do the same.

C. G. BUTLER

---

# NEWS and VIEWS

## Linnean Gold Medal : Prof. W. H. Lang, F.R.S.

THE award by the Linnean Society of London of the Linnean Gold Medal to Prof. W. H. Lang will be regarded with much satisfaction by botanists, and especially palæobotanists, throughout the world. Although in the earlier part of his scientific career his attention was mainly directed to the Pteridophyta and Bryophyta, he later concentrated on investigation of early Devonian plants. During the time he taught in the University of Glasgow his contacts with Robert Kidston inspired him with an interest in palæozoic plants and led to that fruitful collaboration with Kidston in the description of the Devonian plants found in the Rhynie Chert in Aberdeenshire. The results of this investigation, published in the *Transactions of the Royal Society of Edinburgh* between 1917 and 1921, have had a profound influence on our ideas about the evolution of vascular plants, perhaps more than any other palæobotanical discovery of this century. Prof. Lang has made many notable contributions to our knowledge of the morphology of the Pteridophyta and, after collaboration ceased with Kidston's death in 1924, he has continued to investigate early Devonian plants and has shown that important information can be obtained from apparently unpromising and fragmentary plant remains. In collaboration with Dr. Cookson, of Australia, he described the Silurian plants which are found in Australia, the earliest indubitable land plants. His published work, like that of Kidston, has always been marked by meticulous attention to accuracy and he rarely, if ever, makes a statement about a plant which is not clearly demonstrated by photographic reproduction. He has carefully avoided entering the field of speculative morphology, to which the discovery of the Rhynie plants added such a potent stimulus.

## Pure Mathematics in the Imperial College, London: Prof. W. K. Hayman, F.R.S.

DR. WALTER K. HAYMAN, reader in analysis at the University of Exeter, has been appointed to a newly created University chair in pure mathematics at the Imperial College of Science and Technology, London. Dr. Hayman is a brilliant mathematician with an international reputation in his own field, and the value of the contributions which he has made in this field has been recognized by his election at the early age of thirty to a fellowship of the Royal Society. Since graduating in 1946, he has published a number of papers, largely concerned with the behaviour of the maximum modulus of an analytic function which satisfies certain specified conditions. Perhaps the most striking of his results relate to the celebrated conjectures of Bieberbach and Wiman. On one hand he has proved that, if a given function $f(z) = z + a_2z^2 + \ldots$ is schlicht in $|z| < 1$, then Bieberbach's conjecture that $|a_n| \leqslant n$ does hold for

all but a finite number of values of $n$. By an appeal to the method of symmetrization and the idea of the transfinite diameter, he has shown, moreover, that the above is a special case of corresponding results for $p$-valent functions. Again, in an earlier paper he disproved a conjecture of Wiman by showing that, if $m(r)$, $M(r)$ denote the minimum and maximum moduli of a non-constant integral function, then the inequality $m(r) > M(r)^{-A \log\log\log M(r)}$ holds for some large values of $r$ if $A = 2{\cdot}2$, but not always if $A = 0{\cdot}09$. In the course of a short career he has already gained many of the distinctions most coveted by mathematicians. These include the Smith's and Adams's Prizes at Cambridge as well as the Junior Berwick Prize of the London Mathematical Society. Dr. Hayman's early education was received at Gordonstoun School, whence he proceeded in 1943 as a Major Scholar to St. John's College, Cambridge. In 1947 he was elected a Fellow of his College and, after a short period as lecturer at King's College, Newcastle, joined the staff of University College, Exeter.

## Physical Chemistry at Haifa : Prof. F. Kőrösy

Dr. Francis Kőrösy has been appointed head of the Section for Physical Chemistry at the Technion (Technical College), Haifa, Israel. The last two professors in this post were Prof. A. Samuel and Prof. J. Shereshefsky. The Hungarian authorities, in accord with their constant desire to further international cultural co-operation, have given permission to Dr. Kőrösy and his family to leave Hungary for Israel and take up his duties at the Technion, where he is expected to arrive in a few weeks time. Dr. Kőrösy studied at the Technische Hochschule at Karlsruhe and graduated there as Dipl.-Ing.Chem. in 1927. He was awarded a Ph.D. degree with first-class honours at the University of Budapest in 1929 after having worked under Prof. Zemplén in organic chemistry. He returned as assistant to Karlsruhe, working in the Departments of Dr. J. Tausz and Prof. E. Előd on problems of adsorption in connexion with textile chemistry. Returning to Hungary in 1931 he joined the staff of the Tungsram Research Laboratory at the United Incandescent Lamp Co. During his work in this institution he carried out fundamental research on barrier layer cells with the late Prof. P. Selényi and worked with Dr. I. Brody on krypton and on krypton-filled and pressurized incandescent lamps. He published several papers on different subjects of general and inorganic chemistry and invented a buffer preparation against gastric acid disorders. He visited the United States before the War and then returned to Hungary. After the War he became *Privatdozent* at the University of Budapest with applied physical chemistry as his subject and received the degree of *Candidate* in 1953. He has been teaching at the University ever since and has also taught at the evening courses of the Technical University for the past three years. His experimental work and published papers range from pharmaceutical chemistry through organic and inorganic problems, always emphasizing the physical chemist's point of view.

## Directorship of the London Museum : Dr. D. B. Harden

The directorship of the London Museum, which has been vacant since Prof. W. F. Grimes left to become director of the University of London Institute of Archæology (see *Nature*, January 7, p. 16), has been filled by the appointment of Dr. D. B. Harden, who since 1945 has been keeper of the Department of Antiquities and secretary of the Griffith Institute at the Ashmolean Museum, Oxford. Dr. Harden is at present vice-president of the Society of Antiquaries, and during 1950–54 was president of the Council of British Archæology. As honorary secretary of the Museums Association, he has also had much experience of museum problems outside Oxford. He has served on the Council of the British Association and was the recorder of Section H (Archæology) for a number of years. He is an expert on ancient glass. But all these activities, and many more, are of the kind that could be extracted from a book of reference. What would not be mentioned there is his tact and genial personality. It is not easy to be a well-liked and successful recorder of a section at meetings of the British Association. Not only have programmes to be arranged, but also during the meeting itself all the members have got to be kept contented. It may be added that, in this regard, Dr. Harden has always been ably seconded by Mrs. Harden. There can be no doubt that his appointment as director of the London Museum is a wise one, and will be popular.

## Institute of Industrial Management : Awards

The Bowie Medal for 1955 of the Institute of Industrial Administration has been awarded to Mr. E. F. L. Brech, management consultant and senior partner of Urwick, Orr and Partners, Ltd. The Medal, which was established in 1954, is awarded annually to a member of the Institute for a noteworthy contribution to management. Mr. Brech has been chairman of the London Centre of the Institute of Industrial Administration and is at present a member of council ; he was founder-chairman of the Association of Supervisors' Discussion Groups.

The Institute has also awarded the Wilson Medal, and special premium of £25, for 1955/56 to Mr. C. R. Perks (Cardiff Branch) for his paper on the establishment of overseas subsidiaries ; honourable mention has been given to Mr. N. G. Westcombe (London Branch) for his paper on emotional attitudes in management.

## International Geophysical Year : Conference in Paris

The Third Antarctic Conference of the International Geophysical Year was held in Paris during the past week. The United Kingdom delegation consisted of Sir David Brunt (secretary of the Royal Society), Mr. James Wordie, Dr. V. E. Fuchs and experts in those problems likely to be met in next year's Antarctic programme. The delegation presented a report on what has been achieved by the Royal Society advance party, the advance party of the Trans-Antarctic Expedition and the existing bases of the Falkland Islands Dependencies Survey. Other nations, including Australia, France, the United States and the U.S.S.R., also presented reports. The plans for the programme in Antarctica of the International Geophysical Year were discussed ; arrangements for co-operation in radio communications, central weather forecasting services and mutual logistic support were considered.

## Hazards of Nuclear and Allied Radiations

A short debate in the House of Commons on July 16 on the report of the Committee on the Hazards to Men of Nuclear and Allied Radiations was opened by Dr. Edith Summerskill, who urged

that it is of paramount importance not to increase the scale of the present tests of nuclear weapons and that control of such tests with the object of eventual abolition should be our aim. Mr. Richard Foot stressed the importance of the further research work on the genetic effects of radiation and other matters which the Committee recommends should continue, and Mr. A. Blenkinsop, asking whether research work in Britain is adequate, urged the importance of encouraging vigorously all the international research work proceeding in this field. The Minister of Health, Mr. R. H. Turton, replying in the debate, said that the Government regards the expansion of research as a matter of high priority in order that the potentialities of nuclear radiation may be exploited with confidence and safety; immediate action will be taken when the Committee submits to the Medical Research Council its recommendations for future work. The Atomic Energy Authority would have no difficulty in carrying out the recommendations of the report regarding occupational exposure to radiation. He reiterated the Government's intention to do its best to secure progress in the regulation and limitation of test explosions, and mentioned that the Radioactive Substances Advisory Committee, under the chairmanship of Sir Charles Darwin, has prepared a comprehensive code of practice for use in the National Health Service hospitals. This is under final revision and will be issued shortly. To assist in carrying out the code, as well as in applying existing protective measures in hospitals and in industry, a Radiological Protection Service has been set up and, in accordance with the recommendation that present practice in diagnostic radiology should be reviewed and the use of radiotherapy in non-malignant condition critically examined, the Government is appointing a committee of scientists and professional men, with Lord Adrian as chairman, to examine these essentially clinical matters and make recommendations. Recommendations for collecting more detailed information for genetic studies would be discussed with the Registrar General.

## A Winge Festschrift

A VOLUME in honour of the seventieth birthday of the distinguished Danish botanist, Prof. Øjvind Winge, of the Carlsberg Laboratory, Copenhagen, has recently appeared (as Vol. 26 of the *Comptes Rendus des Travaux du Laboratoire Carlsberg*, Sér. Physiologique; pp. 1–443; 1956; 40 kr.). As is appropriate and to be expected, it is concerned almost entirely with the genetics of micro-organisms. It includes a bibliography of Prof. Winge's own scientific publications, these amounting to 120 titles, extending from the year 1907 to date, the whole constituting a notable contribution to a subject of great contemporary interest and increasing importance. The individual papers in the volume have been contributed by eminent exponents in the field of the genetics and physiological genetics of micro-organisms. Some of these relate to specific topics and observations; for example, gigas mutants; others pertain to what is now referred to as the biochemistry of genetics, for example, "The Genetics of Galactose Fermentation in *Saccharomyces* Hybrids"; and yet others deal with more general topics, such as "Genes—their Nature and Function". Altogether, there are twenty-five separate contributions, the overall effect being to provide the reader not only with a representative survey but also to give him a very lively impression of the effort that is being made in different parts of the world in a difficult but rewarding field. Like other publications from the Carlsberg Laboratory, the volume is attractively produced.

## *Journal of Fluid Mechanics*

THE recent increase in the number of investigations, both theoretical and experimental, relating to the study of fluid mechanics has necessitated the launching of a new periodical devoted solely to this subject, the *Journal of Fluid Mechanics*. The *Journal* is to be issued in six parts to a volume of approximately six hundred pages, and the first number has recently been published (London: Taylor and Francis, Ltd.; New York: Academic Press, Inc. 20*s*. or 3 dollars per part; £5 10*s*. or 16.50 dollars per vol.). The editor is Dr. G. K. Batchelor (Cavendish Laboratory, Cambridge), assisted by Drs. T. B. Benjamin and I. Proudman; and Profs. G. F. Carrier (Harvard), W. C. Griffith (Princeton) and M. J. Lighthill (Manchester) are associate editors. The first issue contains eight papers, all of which are of high standard: four relate to aerodynamics, one to oceanography, one to rainfall, and the remaining two, by M. J. Lighthill and M. B. Glauert, respectively, of the Department of Mathematics, University of Manchester, deal with the theoretical discussion of drift and boundary-layer flow on oscillating plates and cylinders, respectively. M. D. Van Dyke (Ames Aeronautical Laboratory, California) obtains a second approximation to the solution of the problem of supersonic flow past unyawed elliptic cones by proceeding from the slender-body theory; L. C. Woods (Sydney) discusses the thrust due to an air-jet flowing from a wing placed in a wind tunnel and establishes that the ideal thrust is almost independent of the jet exit angle; V. Blackman (Princeton) describes a study of vibrational relaxation in oxygen and nitrogen in the range of shock waves of Mach-number speeds 3–10; and N. Rott (Cornell) investigates theoretically the diffraction of weak shock waves near the edge of a sharp wedge. A theory of collisions between small drops in a turbulent fluid, taking into account collisions between equal drops, is given by P. G. Saffman and J. S. Turner (Trinity College, Cambridge), and the results are applied to the case of small drops in atmospheric clouds to test the importance of turbulence in initiating rainfall. Finally, J. Grease (National Institute of Oceanography, Dorking) considers the problem, arising in connexion with the propagation of tides and storm surges in the ocean, of long gravity waves on a rotating Earth approaching a semi-infinite barrier parallel to the wave crests.

## Health Education in Factories

THE health committee of the County Borough of Willesden (London) has been considering means of interesting people in health education (*Health Educ. J.*, **14**; 1956). During the past seven years, health talks on a variety of subjects have been given to religious, social and political organizations, trade unions, and many clubs. The audiences have varied from about twenty to eighty; but there has recently been a tendency for them to decline. Some talks had already been given in factories by special requests from the managements, and it was thought that here appreciative audiences might be found. At the end of 1954 it was decided to explore the possibility

of giving health talks to factory staffs during lunch-hour breaks. Several factory managements were approached and the response was most encouraging. Four talks were given by the Medical Officer of Health to approximately 2,400 factory workers, the attendances ranging from 400 to 1,000. A new drive was made in 1955, and in the first six months of the year fourteen talks were given in factories on subjects including influenza, coughs and colds; cancer; mass miniature radiography; nutrition; accident prevention and sepsis. With the outbreak of poliomyelitis in the beginning of July 1955, a new stimulus was given to the work. Most factories were only too willing to provide facilities for a talk on this subject, and some of them approached the health department direct. Altogether, up to the end of October, ninety-six talks were given in eighty factories to 23,500 workers. The number in the audience varied from 20 to 4,000, with the majority in the range of 100 to 200. Co-operation with the factory management was not easy at first. Personal contact with the personnel or works manager was necessary.

## Row-crop System for Grass

The technique of growing grass in wide rows instead of in broadcast stands was first developed for grass, chiefly cocksfoot, intended for seed production. Coupled with heavy dressings of nitrogen, part of which was applied in late summer, this system was found to give increased yields of seed and, incidentally, to prolong the growing season well into the winter. With the post-war drop in seed prices, the emphasis has changed and the interest now lies in how the row-crop system may best be used by the grazier. Some account of Scottish experiences with the method is given by I. V. Hunt in an article entitled "Rowcrop Grass", published in the autumn number of *Scottish Agriculture* (Edinburgh: H.M.S.O.; 1*s*.). The grass is sown in strips 12–28 in. apart, with inter-row cultivation in the initial stages. In the summer the crop is grazed or cut for hay, silage or dried grass. Fertilizer is then applied and later growth kept for winter grazing. Cocksfoot has so far proved the most suitable grass; but trials are in progress with timothy, meadow fescue and perennial ryegrass. A seed crop should be possible from cocksfoot and meadow fescue without prejudicing the winter grazing, but timothy would ripen too late. Other promising features of the system are the reduction in waste from treading, winter burning, or rotting, earlier growth in spring and considerable reduction in the cost of seed. The method is still in the experimental stage; but it has steadily gained favour on English and Welsh farms and may prove of special use in Scotland where the grazing season is normally short.

## Cultivation of Lucerne in Britain

The acreage under lucerne in England and Wales has now reached some 112,000 acres, half of which lies in East Anglia, Kent and Lincolnshire. The crop requires skill in management and makes heavy demands on soil fertility; but its drought-resistant properties and vigorous growth during the summer make it a valuable plant for the establishment of leys, and it can be profitably grown in all parts of Britain. Memoir No. 1 of the Grassland Research Institute, entitled "Lucerne Investigations 1944–1953" (pp. 81; from the Institute, Hurley, near Maidenhead, 1955; 10*s*.), should help farmers to utilize this crop better, for it gives the results of critical field experiments carried out by the Institute and the National Agricultural Advisory Service in different parts of the country. Information regarding the different strains of lucerne is provided in an article contributed by the National Institute of Agricultural Botany, Cambridge; from the trials at the Grassland Research Institute, the early long-season type appears to have given the most promising results so far. Much attention is devoted to the subject of management, including that of leys where the lucerne is associated with different companion grasses. Remarkable differences in yield can be obtained by changes in timing the cuts, autumn being a specially critical period. A useful bibliography is included in the memoir.

## Germination Regulation in Desert Seeds

The regulation of germination in the seeds of the desert leguminous species *Colutea istria* Mill. has been investigated in some detail by D. Koller and M. Negbi (*Bull. Res. Council Israel*, Sect. D, Botany, **5***D*, 1, 73; 1955). The seeds were found to be largely impermeable to water. This could be remedied either by treatment with concentrated sulphuric acid, or by vigorous shaking in a glass jar. Swelling was more rapid after the former treatment. It was found that, whereas acid treatment removes impermeability by acting all over the surface of the seed coat, the shaking did so only in the micropylar region. Permeable seeds germinated equally well in light and in dark, and their germination was insensitive to temperature between 20° and 30° C. Seedling growth in dark exceeded that in light. The two seed samples investigated, which were collected in different years and locations, differed widely in germination. This was apparently caused by different degrees of maturity which the embryos had attained before fruit ripening. Two separate coats surround the embryo. The inner coat has no influence on germination in the fully 'ripe' sample, but in the 'unripe' sample it affords the embryo some kind of protection against decay. The outer coat in both samples contains a water-soluble growth inhibitor, which retards embryo growth. Successful reseeding of depleted desert pastures was carried out with this species in the Negev Highlands.

## Nuclear Differences in Onion Root Tissue

In former years it was generally assumed that the cells of the various tissues of a higher plant had nuclei the constitution of which was identical with that of the fertilized ovum. Some recent investigations have shown, however, that the nuclei in all cells are not alike. A. L. Chouinard (*Canad. J. Bot.*, **33**, No. 6, 628; 1955) has contributed to this topic by observing the nuclear differences in onion (*Allium cepa*) root tissues as revealed by the induction of mitosis with indoleacetic acid. Treatment with this growth substance was used for stimulating mitosis in differentiated tissues of *Allium cepa* roots in order to establish whether nuclear differences, specifically in chromosome number, exist normally and are merely revealed by treatments, or whether these nuclear differences are produced by the treatment. With the concentrations of indoleacetic acid and durations of treatment used, evidence was obtained that chromosome number differences exist in the differentiated tissues of onion root prior to any treatment, and that the appearance of these differences after treatment is a matter of revelation and not of causation. The evidence obtained in these investigations comes

indirectly from observations of nuclear size and structure and directly from rare spontaneous mitoses in untreated roots, and in the treated roots (1) from the absence of nuclear abnormalities which might explain otherwise the origin of polyploid cells, (2) from the uniform occurrence of certain chromosome numbers in specific root tissues, (3) from proportions of diploid and polyploid divisions during mitotic induction, and (4) from the lack of relationship between total mitotic activity and number of polyploid mitoses. A gradient of endomitotic polyploidization exists in certain tissues along the longitudinal axis of the onion root.

## Rubber Diseases in the Belgian Congo

R. J. PICHEL (with the collaboration of C. Maertens) has produced a monographic study of rubber diseases and their control in the Congo basin (l'Inst. Nat. pour l'Étude Agr. du Congo Belge, Sér. Tech. No. 49; pp. 1–450, 1956; 400 fr.). The first part of the book deals with the general problem of disease in rubber and the causative agents, the root-attacking fungi *Fomes lignosus* (*Rigidoporus microporus*) and *Armillaria mellea* being of outstanding importance, as they also are in other rubber-growing regions. The attitude of the author to his subject is practical rather than detailed and specialized. The second part is devoted to observations on the biology of root-destroying fungi and the behaviour of *Hevea* under attack. The problem of infection courts is given special attention, and the processes and factors involved in contamination, infection and effective parasitism are considered at some length. In the third section, the epidemiology of the diseases and the efficacy of control measures are described with special reference to the considerable volume of work carried out at Yangambi, the effects of both direct methods and cultural treatments in controlling the pathogens being considered. The fourth section is concerned with control measures and the economic aspects of the problem. The conclusions and recommendations at the end represent a synthesis of the experience and the effort made in this field by the Belgian Congo workers at the Yangambi Research Station during recent years. The work is illustrated by a large number of excellent photographs, coloured plates and diagrams. This monograph contains a great deal of new observation of interest and importance to both pathologist and planter. A bibliography of more than three hundred titles is included.

## Breeding of Shags on Lundy Island

DURING 1954 and 1955 observations were made on the breeding habits of shags on Lundy Island, and these have been described in the ninth annual report of the Lundy Field Society. Sufficient material was collected for some factors to emerge which appear to affect breeding success. The two years showed practically no difference in the pattern of clutch size although the weather was dissimilar. In both years there was a great predominance of clutches of three; there is a tendency for clutches laid later in the breeding season to be of a size greater, or less, than three. There was a striking similarity of hatching and fledging success in the two years, 93·6 per cent of young hatched during the two years reaching the flying stage—a remarkably high percentage. Even so, the number of young fledged was not sufficient to secure replacement of breeding adults. From the evidence of recoveries the yearling mortality is fairly high, and the species appears not to breed until at least three years old. Adults must average several seasons of breeding in order to replace themselves. All nests found have been divided into those situated under rocks and those open to the sky or with only slight rock overhang; covered nests are significantly more successful than open nests. Young in covered nests have shelter from rough weather and seas, and are not liable to be inadvertently pushed out of the nest and possibly over the cliff. Another significant factor in fledging success is the date of hatching. The earlier nests have a markedly higher rate of success than the late nests. It will be interesting to compare these results with those obtained by E. White and J. C. Coulson, who are studying shag mortality on the Farne Islands.

## Zoological Nomenclature

As from December 12, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details have already been published (*Bull. Zool. Nom.*, **12**, Pts. 1 and 2; June 1956). (1) *Paradoxides* Brongniart, 1822, validation; *Olenus* Dalman, [1827], designation of type species for; *paradoxus* Linnaeus, 1759 (*Entomolithus*), suppression and Paradoxiden Emmrich, 1844 (wrongly based on *Olenus*) suppression (Cl. Trilobita); (2) *munda* Kuhl, 1820 (*Proc.*[*ellaria*] and *Nectris*), suppression (Cl. Aves); (3) *Daira* de Haan, [1833], validation (Cl. Crustacea, Order Decapoda); (4) *tuberculatus* Hall, 1859 (*Acidaspis*), validation; *Acanthaloma* Conrad, 1840, suppression (Cl. Trilobita); (5) *Theridion* Walckenaer, 1805 (Cl. Arachnida), designation of type species for; (6) *Protopeltura* Brögger, 1822 (Cl. Trilobita), designation of type species for; (7) *punctata* (*Querquedula*), validation of, as from Sclater (P.L.), 1880, as name for the hottentot teal (Cl. Aves); (8) *Trinucleus* Murchison, 1839, validation of; *tuberculatus* Link, 1807 (*Trinucleus*), suppression (Cl. Trilobita); (9) *Panulirus* White, 1847, validation; *commune* Leach, 1818 (*Phyllosoma*) and *rissonii* Desmarest (*Palinurus*), suppression (Cl. Crustacea, Order Decapoda); (10) *Illaenus* Dalman, [1827], protection of by suppression of *Cryptonymus* Eichwald, 1825 (Cl. Trilobita). Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

## Ordnance Survey Map of Roman Britain

BRITAIN was under Roman rule for nearly four hundred years, and, though subsequent influences from beyond the North Sea and from Normandy profoundly affected its people and their way of life, yet in many things the Roman pattern remained an ideal. A detailed survey of the various categories of Roman remains is therefore of great interest, and the new, third edition of the "Ordnance Survey Map of Roman Britain" is very welcome (pp. 43+1 map; paper flat, 3*s*. 3*d*.; folded, with text, 7*s*. 6*d*.; text only, 3*s*.). Much has been discovered since the last edition appeared about a quarter of a century ago, and methods of investigation have vastly improved. In every way the present publication is a great advance on the last, and Mr. C. W. Phillips, archæological officer for the Survey, is to be congratulated. It is a pity, perhaps, that such a large map had to be printed on such thin paper. It will not stand much use away from the study table,

unless extracted and framed. A map of such general interest might well have been issued on paper of such a quality that it would stand up to use in the field by the investigator and by the amateur when travelling about the country. But it is a fine piece of work, and it will be a long time before another revise is needed.

## Distribution of Prehistoric Rock Engravings and Paintings in South Africa

An up-to-date gazetteer of all the sites in the Union of South Africa and South West Africa where rock-shelter paintings and engravings on rocks occur was prepared by the late Prof. C. van Riet Lowe and has been published by the Archæological Survey of the Union under the title: "Distribution of Prehistoric Rock Engravings and Paintings in South Africa" (Archæological Series No. 7. Pp. 58. Johannesburg: Union Education Department, 1956; 10*s*.). The arrangement is by provinces and districts, which makes it easy to use, especially as there is a foreword where the various groups are described. The publication will be very useful to prehistorians visiting South Africa and wishing to study a number of painted and engraved sites. There is an excellent distribution map.

## Measuring the Load on Pit Props

From the earliest days of mining the support of the roof of the tunnel driven has been a question of the first importance. With the ordinary handwork at the pit face, it had come to be accepted in Western Europe that the coniferous pit prop was the safest that could be obtained, as it gives warning before breaking to collapse. Metal substitutes have had a brief trial; but they give no such warning. The successful development of mechanized systems of mining have brought other difficulties, and the wooden coniferous pit prop is no longer free from suspicion. This matter is dealt with in *Science Bulletin* No. 4 (Spring 1955) of the Scientific Department, National Coal Board (pp. 24; from the Board, London). Some sound roof control is of paramount importance, if mechanized systems of mining are to be introduced and accepted, to prevent falls of the roof on the coal face, and also to improve the workability of the coal seam. Attempts have been made in the past to undertake a complete study of roof control, entailing the measurement of the forces acting actually within the coal and the surrounding strata, but considerable problems are involved. Information can, however, be obtained from a study of the movements of the roof supports and of the loads they carry. For example, a study of the loads carried by the front row of props will help to show whether a prop-face front can be used. An instrument, called a load cell, has been devised which will register the load carried by a prop when placed between the prop and a roof bar. The load cell is small and robust, so that it can be set easily and will not interfere with the normal behaviour of the prop, and already it has been used for a number of investigations.

## Seismic Observations on a Large Explosion in North-East Japan

On September 13, 1953, at 3h. 4m. 57·074*s*., the second large explosion at the Kamaisi mine of the Nippon Iron Works (lat. 39° 17′ 39·9″ N., long. 141° 41′ 32·9″ E.) to be observed seismically occurred, this being the fifth explosion to be observed seismically by the Japanese Research Group for Explosion Seismology (*Bull. Earthquake Res. Inst., Tokyo Univ.*, 33, Pt. 4, 699; December 1955). The aim of the blasting operation was to remove dangerous gangue rocks as a safety measure, and the letting off of 42 tons of explosives was operated in seven steps, which took altogether 84 milliseconds from first to last. From a seismic point of view, this method is less effective than if the whole mass had been let off at once. Fourteen seismograph stations for refraction shooting were placed from near the shot point to a distance of 332 km., the most sensitive instruments being placed 170–332 km. distant. Most of the seismographs used were vertical electromagnetic instruments, working at 3 c./*s*., though the nearest worked at 10 c./*s*., and an additional one at the most distant station worked at 0·7 c./*s*. Horizontal electromagnetic seismographs were operating at six stations, working either at 3 c./*s*. or 1 c./*s*. The line of fourteen stations was almost parallel with, and near, the east coast line from about lat. 36° 33′ N. to about lat. 39° 18′ N. In addition, a special station was established at Umanokiuti ($\Delta = 4{\cdot}63$ km.) to make observations of reflected waves. *P*- and *S*-wave onsets were read at most stations, and travel-time curves constructed from the results. On the assumption of horizontally disposed layers, the *P*-wave indicated a layer of thickness between 22 and 25 km. in which the velocity was 6·05 km./sec., overlying a layer in which the velocity of *P*-waves was 7·2–7·6 km./sec. Reflexion experiments tended to confirm this thickness for the upper layer. Results from the *S*-wave alone gave a thickness of between 32 and 36 km. for the upper layer in which the velocity of the *S*-wave was 3·46 km./sec., overlying a stratum in which the velocity of the *S*-wave was between 4·5 and 4·8 km./sec. The discrepancy in the estimate of thickness of the upper layer may be due to the influence of a more complicated structure than that assumed. This is to be investigated.

## Scientific Instrument Manufacturers' Association: Officers for 1956–57

The following have been elected officers for 1956–57 of the Scientific Instrument Manufacturers' Association: *President*, G. A. Whipple (Hilger and Watts, Ltd.); *Vice-President*, P. Goudime (Electronic Instruments, Ltd.); *Honorary Secretary*, J. E. C. Bailey (Baird and Tatlock (London), Ltd.); *Honorary Treasurer*, C. H. Warner (W. F. Stanley and Co., Ltd.); *New Members of Council*, F. W. Dawe (Dawe Instruments, Ltd.), P. J. Ellis (R. B. Pullin and Co., Ltd.), J. M. Furnival (Marconi Instruments, Ltd.), D. F. Newstead (Kershaw Division, Rank Precision Industries, Ltd.), J. A. Stafford (Taylor, Taylor and Hobson, Ltd.), W. H. Storey (Unicam Instruments, Ltd.) and N. Trepte (Griffin and George, Ltd.).

## University of London

Dr. L. A. Elson, British Empire Cancer Campaign Intermediate Research Fellow, has been appointed to the University of London readership in biochemistry tenable at the Institute of Cancer Research, Royal Cancer Hospital, London. The title of professor of experimental pathology (histopathology) in the University of London has been conferred on Dr. E. S. Horning, in respect of his post at the Institute of Cancer Research, Royal Cancer Hospital, and that of reader in physical organic chemistry in the

University of London on Dr. Victor Gold in respect of his post at King's College. The title of professor emeritus in the University of London has been conferred on the following on their recent retirement from chairs tenable at the institutes indicated: Prof. H. Berry (pharmaceutics at the School of Pharmacy); Prof. V. G. Childe (prehistoric European archæology at the Institute of Archæology); Prof. S. J. Davies (mechanical engineering at King's College); Prof. S. J. Cowell (dietetics at University College Hospital Medical School); Prof. H. T. Flint (Hildred Carlile chair of physics at Bedford College); Prof. L. Hawkes (geology at Bedford College); Prof. W. J. John (electrical engineering at Queen Mary College); Prof. A. Meyer (neuropathology at the Institute of Psychiatry); Prof. A. J. S. Pippard (civil engineering at the Imperial College of Science and Technology); Prof. H. Raistrick (biochemistry at the London School of Hygiene and Tropical Medicine); and Prof. R. A. Webb (pathology at the Royal Free Hospital School of Medicine).

## Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: C. J. Allen (agricultural officer, Jamaica), senior livestock officer, Department of Agriculture, Jamaica; E. J. H. Berwick (senior agricultural officer (grade A), Federation of Malaya), director of agriculture, North Borneo; A. E. Billington (senior research officer (grade B), Federation of Malaya), senior research officer (grade A), Federation of Malaya; F. B. Brown (botanist, Federation of Malaya), senior research officer (grade B), Federation of Malaya; P. G. Coleman and P. A. Gething (senior agricultural officers (grade B), Federation of Malaya), senior agricultural officers (grade A), Federation of Malaya; C. North-Coombes (agricultural economist, Gold Coast), assistant director of agriculture, Gold Coast; J. K. Coulter (soils chemist, Federation of Malaya), senior research officer (grade B), Federation of Malaya; W. H. Edwards (agricultural officer, Uganda), assistant director of agriculture, Uganda; J. H. Gisborne (assistant director of agriculture (research), Northern Region, Nigeria), deputy director of agriculture (research), Northern Region, Nigeria; W. C. H. Hill (senior agricultural survey officer, Department of Agriculture, Gold Coast), principal agricultural officer, Department of Agriculture, Gold Coast; H. M. James (agricultural officer, Federation of Malaya), senior agricultural officer (grade B), Federation of Malaya; G. B. Kennard (senior field officer, British Guiana), deputy director of agriculture, British Guiana; M. D. ffrench-Mullen (managing director, Berbice Fibre Research Co., Ltd., British Guiana), deputy director of agriculture, British Guiana; H. J. Simpson (senior agricultural officer (grade A), Federation of Malaya), assistant director of agriculture (field), Federation of Malaya; D. Westwood (senior agricultural officer, Gold Coast), principal agricultural education officer, Gold Coast; P. St. J. Matthews (forester (grade II), Kenya), assistant conservator of forests, Kenya; D. S. P. Noakes (deputy director of forestry, Federation of Malaya), director of forestry, Federation of Malaya; B. E. St. L. Stuart (research officer, Forestry Division, East Africa High Commission), assistant conservator of forests, Kenya; L. C. M. Wedderburn (senior assistant conservator of forests, Northern Region, Nigeria), conservator of forests, Northern Region, Nigeria.

## Announcements

PROF. SYDNEY CHAPMAN, visiting professor of geophysics in the University of Alaska, has been awarded by the Accademia Nazionale dei Lincei, Rome, the international prize, on the Antonio Feltrinelli Foundation, for astronomy, geodesy, geophysics and their applications.

SIR HAROLD SPENCER JONES has been appointed secretary-general of the International Council of Scientific Unions in succession to Prof. A. V. Hill, who has retired.

MR. I. EDWARD GARRICK, chief of the Dynamic Loads Division, Langley Laboratory, Virginia, of the U.S. National Advisory Committee for Aeronautics, has been appointed to the Jerome Clarke Hunsaker chair at the Massachusetts Institute of Technology. This chair, which is for aeronautical studies, is held for a year, and the previous occupant was Prof. W. Hawthorne, professor of applied thermodynamics in the University of Cambridge. Mr. Garrick is a leading authority on aircraft 'flutter'.

THE autumn meeting of the Institute of Metals will be held this year in Germany during September 17–25. The meeting will consist of a large number of excursions to engineering works and other places of interest, and will be based in Stuttgart until September 23, and in Frankfurt am Main thereafter. During September 17–18 joint scientific sessions will be held with the Deutsche Gesellschaft für Metallkunde. Registration forms can be obtained from the Secretary, Institute of Metals, 17 Belgrave Square, London, S.W.1.

THE fourth instruments and measurements conference and exhibition, organized by the Royal Academy of Engineering Sciences and the Swedish Association of Technical Physicists, will be held in Stockholm during September 15–23. The conference will consist of six sections: nuclear instrumentation; automation; physical methods for chemical analysis; spectroscopy; optics; and computers. Further information can be obtained from the conference secretary, Sven Malmström, P.O. Box 12035, Stockholm 12.

AN international congress of clinical chemistry will be held in New York City during September 9–14 under the auspices of the International Federation of Clinical Chemistry and the Commission of Clinical Chemistry of the International Union of Pure and Applied Chemistry. The principal theme of the congress will be the significance of metabolic systems in clinical chemistry. Further information can be obtained from the congress secretary, Dr. John G. Reinhold, 711 Maloney Building, Hospital of the University of Pennsylvania, Philadelphia 4, Pa.

THE Department of Civil and Municipal Engineering of University College, London, is offering two courses in photoelasticity. The first is a short refresher course, which will be held during September 3–14 (fee £8). The other is a full course extending over the academic year 1956–57, and comprises weekly lectures on the theory and methods of photoelasticity (fee, £14) with, when possible, one or two days a week practical work in the laboratories (fees, £11 and £16 respectively). Applications should be made to the Secretary, University College, London, Gower Street, W.C.1.

# NEW NATURE RESERVES IN BRITAIN

THE Nature Conservancy has announced the establishment of two new nature reserves in England and the addition of further areas to two existing reserves. The new reserves are Lullington Heath (three and a half miles north-west of Seaford, Sussex) and Cothill (five miles south-south-west of Oxford), and the additions are to the Newborough Warren and Ynys Llanddwyn nature reserve, Anglesey, and the Axmouth–Lyme Regis undercliffs nature reserve, Devon.

Lullington Heath is one of the largest areas of unploughed chalk heath remaining on the South Downs. It was under cultivation in prehistoric times, and the boundaries of rectangular fields can still be traced, especially in the north-west corner of the reserve. Fragments of pottery and iron slag show that people not only farmed but lived and worked there. Far from reducing the biological value of the reserve, these traces of long-past soil disturbance add to its interest, and provide a link with agricultural history. The reserve covers an area of 155 acres and is being declared under a sub-lease from the Forestry Commission, which leases the area from the Eastbourne Waterworks Company. It appears that the land has been used only for grazing, without cultivation, for many hundreds of years; the lime has been leached from the surface layers, which are acid, even though the chalk is only a few inches below. In consequence, shallow-rooted plants which need acid soil—for example, bell heather and ling—are mingled with deep-rooted plants such as salad burnet and dropwort, which need limy soil. By April 1954 myxomatosis reached Lullington and almost exterminated the formerly dense rabbit population, and this set in motion changes in the vegetation. Careful records have been made of these changes, which form an important part of the national record of the results of myxomatosis. It is important that the long-term research work which is in hand on this reserve should not be disturbed, and applications for collecting specimens of animals or plants or changing the fauna or flora in any way should be made to the Conservancy's regional officer for the south-east at 19 Belgrave Square, London, S.W.1.

The Ruskin Reserve at Cothill, Berks, has been protected since 1917 by the National Trust in co-operation with the Ashmolean Natural History Society, and it has been declared a nature reserve under a lease with the National Trust. Four and a half acres in extent, it has long been noted for the richness of its flora and fauna and is used for university teaching and research, together with other adjoining areas, for the protection of which the Nature Conservancy is negotiating. The fen occupies a basin, on the edge of the Jurassic (Corallian) Calcareous Grit, which is the meeting point of several streams carrying highly calcareous water; the outflow is at Sandford Brook. It seems probable that much of the valley was flooded in medieval times; two ponds can still be found in the Ruskin Reserve. These show the succession from open water through various swamp associations to woodland of alder, birch, ash and other trees, the development of the vegetation being accompanied by progressive acidification of the surface peat. Access to the reserve will be by permit only, applications for which should be made to the Conservancy's regional officer for the south, at the Furzebrook Research Station, Wareham, Dorset.

The Newborough Warren and Ynys Llanddwyn nature reserve, covering an area of 283 acres, was declared in June of last year, and the present declaration, which is made under a lease with the Glynllivon Estate, adds a further 500 acres extending from Rhosddu Lake up to, but not including, Abermenai Point. Although in Anglesey, it is only some three miles west of Caernarvon across the Menai Strait. Newborough Warren is one of the largest, and biologically richest, expanses of dunes in western Britain. A large-scale encroachment of the land by inundation of sea and sand was recorded in 1331; as a result of the planting of marram grass, the dunes have progressively become more stabilized, and some of them now rise more than 50 ft. above sea-level. It is one of the earliest occupied sites in Anglesey, and Mesolithic flint sites show occupation by man probably between 7000 and 5000 B.C. Stages of sand-dune succession are shown on a large scale, including shifting dunes, willow dunes, and marsh and fixed dunes. There are extensive 'slacks'—damp dune hollows—which are occupied by open communities of creeping willow. The 'slacks' are rich in plant life, some rarities being recorded and some species which are normally associated with mountain habitats. The dunes are important for biological and physiographical research and are much used by workers, especially from the University College of North Wales, Bangor. There will be no restriction on rights of way, but to collect specimens permission is needed from the conservation officer, c/o School of Agriculture, University College of North Wales, Memorial Buildings, Bangor, Caernarvon; the warden for the reserve is Mr. R. D. P. Morgan, Serai, Malltraeth, by Bodorgan, Anglesey.

The Axmouth–Lyme Regis undercliffs nature reserve extends over Bindon, Dowlands, Pinhay and Ware Cliffs, in Devon, and was established by the Conservancy in March of last year. There was then a large gap in the middle of the reserve which has now been filled by the additional area of 86 acres recently declared under a lease with the Governors of Allhallows School. This consists of the Rousdon and Charton Cliffs, and brings within the reserve the whole of the undercliffs stretching along 6½ miles of coast and covering 794 acres. The reserve is the largest and most important landslip area on the coast of Great Britain, records dating from the sixteenth century showing that there have been periodic slips of the Chalk and underlying Greensand on the Gault and Lower Lias Clays which dip towards the sea. The most spectacular slip recorded was at Dowlands on Christmas Day, 1839, when nearly eight million tons of rock subsided from a cliff 375 ft. high, leaving a vast chasm half a mile long and ranging from 200 to 400 ft. in width. The mixture of a wide range of rocks, which are mainly typical of south-eastern England, has led to a great variety of soils. Although between 1839 and 1905 very few trees established themselves on the floor and the sides of the chasm near Dowlands, since 1905 a fine isolated natural ash wood has come to maturity, this being almost the only known instance of the production of a mature ash wood on a virgin site without human interference within a precisely known period of time. Similar,

but less striking, growth of natural vegetation has occurred on the Rousdon and Charton Cliffs. Owing to the inaccessibility of much of the ground and the continued risk of further slips, there has been an almost unique freedom from human disturbance there. Permits to collect specimens or to visit parts of the reserve away from the footpath will be needed, application for which should be made to the Conservancy's regional officer for the south-west at the Furzebrook Research Station, Wareham, Dorset; the warden for the reserve is Mr. L. A. Pritchard, Lynch Cottage, Rousdon, near Lyme Regis.

## THE MUSEUMS ASSOCIATION

### ANNUAL CONFERENCE IN THE NETHERLANDS

THE sixty-second annual conference of the Museums Association was held jointly with De Museumdag in Amsterdam during June 27–30. Owing to the provisions of the Companies' Act, it was necessary to hold the annual general meeting in Britain, and this took place at University College, London, before delegates embarked for Holland. After welcoming some 320 delegates to the conference, the retiring president, Dr. F. S. Wallis (director of the City Museum, Bristol), gave an address on some of the recent activities of the Association. He outlined the negotiations with the Government concerning assistance to museums and more especially to private and trustee museums. The generous help of the United Kingdom Carnegie Trustees was acknowledged, and the great effect of their grants on museum work in Britain over the past twenty-six years was stressed. Dr. Wallis also referred to the value of the various regional federations, the courage of the governing bodies and curators of small museums, and the need for more committees to utilize the provisions of the Local Government Act of 1948 whereby financial assistance may be given to further local efforts of a cultural character.

In Amsterdam, delegates were joined by members of De Museumdag under their president, Dr. J. C. Ebbinge Wubben, and an official welcome was given by Mr. F. P. Th. Rohling on behalf of the Minister of Education, Arts and Sciences and the Burgomaster of Amsterdam. Afterwards, Prof. E. K. Waterhouse read a paper on "British Collections and Dutch Art", in which he reviewed the interrelationships of English and Dutch art with especial reference to the seventeenth-century artists. Another series of papers, by Dr. A. B. de Vries, Sir Philip Hendy, Dr. W. E. Swinton and Dr. D. B. Harden, discussed museum displays in the Netherlands and Britain since 1945. The conference was unusual in that papers were reduced to those already mentioned, and visits to museums and art galleries to study technical and display methods were increased to the maximum possible. During the period the institutions in Amsterdam, Rotterdam, The Hague, the National Park in Otterlo, Arnhem, Leyden, Gouda, Utrecht and Delft were visited. Hospitality was lavish on all occasions.

The president of the Museums Association for 1956–57 is Sir Philip Hendy (director of the National Gallery, London), and the next annual conference of the Association will be held in Bristol during July 8–12, 1957.

## METEOROLOGICAL PROGRAMME OF THE INTERNATIONAL GEOPHYSICAL YEAR

A NUMBER of important articles on the meteorological programme for the International Geophysical Year, planned by the responsible Working Group of the World Meteorological Organization, with Prof. J. van Mieghem (Belgium) as chairman, are to be found in the January and April numbers of the Organization's *Bulletin*. The intention of the programme is to increase knowledge of the meteorology of the tropics and of the upper air in all latitudes. Priority has been given to problems which are fundamentally world-wide in character, so that their solution calls for effective international collaboration, and local or regional questions have not been considered.

In synoptic and dynamical meteorology the problems to be attacked are as follows: the redistribution on a planetary scale of momentum, absolute vorticity, energy and momentum, including frictional and topographical effects; exchange of heat and momentum between the atmosphere and oceans; flow patterns in low latitudes, including interaction between the southern and northern hemispheres; and the distribution of precipitation, especially over the oceans, in relation to large-scale flow patterns. The data collected in this work will assist also in such problems as meteorological influences on the Earth's rotation and the 'model' atmospheres used in numerical forecasting. In physical meteorology the subjects for observation are the distributions of ozone and water vapour, the heat balance of the atmosphere, and the large-scale features of the electric field in the atmosphere.

To ensure comparability of records, it is recommended that the instruments to be used should be compared with national standards and that the World Meteorological Organization should arrange a world-wide comparison of national radiosondes. It is recommended that special efforts be made by every country to make daily two radiosonde observations of pressure, temperature and humidity, and four of wind, up to at least 50 mb. (about 78,000 ft.) and, if possible, to attain the 10-mb. level (103,000 ft.). As regards radiation, the Working Group recommends that observations of the total short-wave radiation (that is, direct solar beam and short-wave sky radiation) should be made at stations in all types of climate to establish for all parts of the world the empirical formulæ for determining global radiation from sunshine duration. Besides this, measurements are recommended of the ultra-violet radiation, of the spectral distribution of energy in solar radiation, and of the long-wave radiation at the surface. The vertical distribution of ozone, so important in studies of ultra-violet radiation, is to be measured, in particular in the sub-tropical anticyclone belt.

For the study of meridional exchanges it is important to be able to draw good meridional cross-sections. The Group proposes that meridional sections shall be drawn from pole to pole along meridians 180°, 140° E., 75° E., 10° E. and 75° W. The first is especially important as giving an oceanic section almost from pole to pole. Minor sections are to be made along other meridians—for example, along the tropical parts of 30° E. and 110° E. It is

hoped that aerological stations will be set up in sufficient numbers along these meridians to enable good cross-sections to be drawn.

As regards publication of meteorological data for the year, the World Meteorological Organization has taken the bold step of deciding to use microcards. National meteorological services are to be asked to send a copy of the observational records of their stations to the secretariat, where they will be printed on microcards and sold. A trial of the method is to be held in January 1957.

## THE PHYSICAL SOCIETY

### ANNUAL REPORT FOR 1955

AT the annual general meeting of the Physical Society, held in London at the offices of the Society on May 24, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1955 were presented and adopted, and the officers and council for 1956–57 were elected. The council reported that the balance of income over expenditure for the year under review was £1,220. However, it should be noted that expenditure for 1955 was more than £9,000 greater than for 1954, £4,000 of this increase being due to the greater expense of housing the thirty-ninth annual exhibition of scientific instruments and apparatus in the New Hall of the Horticultural Society instead of in the Imperial College of Science and Technology, London, where former exhibitions were held. Interest in the exhibition was as great as ever, the attendance exceeding eighteen thousand, and the increased expenditure on the exhibition was more than balanced by a gain in receipts from exhibitors.

The activities of the Society during the year included five science meetings in London; three joint colloquia with the Institute of Physics on electron physics in London; a three-day meeting at the Atomic Energy Research Establishment, Harwell, during March 31–April 2; and two-day meetings at the Universities of Liverpool and Cambridge during July 5–6 and December 13–14, respectively. A highly successful innovation was a Fellow's luncheon, which was held in London on April 25, the opening day of the annual exhibition. The eighteenth Thomas Young Oration was delivered by Dr. W. S. Stiles, who spoke on the basic data of colour matching and some related aspects of visual theory, and the thirty-ninth Guthrie Lecture by Prof. E. C. Stoner on magnetism in retrospect and prospect; both these lectures have been published in the "Year Book of the Physical Society, 1955". Dr. N. Kurti was the recipient of the tenth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place in Paris on May 26, when Dr. Kurti delivered the Holweck Discourse entitled "Le domaine des températures où regnent les spins" (*J. Phys. et le Rad.*, **17**, 85; Feb. 1956). The thirty-second Duddell Medal was presented to Dr. R. Kompfner, who gave an address on travelling-wave tubes, and the eleventh Charles Vernon Boys Prize to Dr. J. W. Mitchell, who spoke on some of his work on photographic emulsions.

The Society continues to be represented on various committees and institutions, details of which are listed in the annual report, together with brief accounts of the activities of the four Groups of the Society—the Colour, Optical, Low Temperature and Acoustics Groups. The summer meetings of the Colour and Optical Groups were held at the Paint Research Station, Teddington, and University College, London, respectively, while the Low Temperature Group for its summer meeting paid a visit to the British Oxygen Company's air separation plant at Brinsworth, to the United Coke and Chemicals Company's hydrocarbon separation plant at Handsworth and to the Low Temperature Physics Laboratory at the University of Leeds.

In the section of the report dealing with publications, it is stated that, after a three years trial, the reprints scheme, whereby members and subscribers of the Society were able to purchase reprints of the papers published in the Society's *Proceedings*, has had to be discontinued. The general demand for the scheme was far too small to justify the large expense involved. Two conference reports, "Defects in Crystalline Solids", the report of a conference held in Bristol during 1954, and "The Physics of the Ionosphere", the report of a conference held in Cambridge during 1954, which were mentioned in the 1954 annual report, were published during 1955, and Volume 18 of "Reports on Progress in Physics", containing ten specialist articles, was issued in September. The flow of papers to the *Proceedings* increased during 1955. 265 papers and 115 research notes and letters to the editor were accepted for publication, as compared with 215 and 111 respectively in the previous year. Seventy-three manuscripts were either rejected or withdrawn. A new annual publication, commenced in the autumn of 1955, was "The Year Book of the Physical Society", containing the texts of the presidential address, the Guthrie Lecture and other special lectures to the Society, in addition to the annual report and accounts.

The officers and council of the Society for 1956–57 are as follows: *President*, Prof. N. F. Mott; *Vice-Presidents* (in addition to those who have filled the office of president), Dr. A. B. Wood, Prof. S. Devons, Prof. F. Llewellyn Jones and Prof. H. Jones; *Honorary Secretaries*, Dr. C. G. Wynne and Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Ordinary Members of Council*, Dr. V. E. Cosslett, Dr. D. Gabor and Mr. E. S. Shire.

## THE DELI PALM

A RECENT issue of the *Journal of the West African Institute for Oil Palm Research* (No. 3, pp. 5–87; 1955) contains a number of articles of interest both to botanists and planters. It is an odd and sometimes disconcerting fact that a haze of obscurity overhangs the origin of so many of our major crops. This is particularly true of the Deli palm—a strain of *Elaeis guineensis* that has been cultivated with great success in the East—concerning which an important article is contributed by A. F. M. Broekmans and F. W. Toovey. Seed of the Deli palm was introduced into Nigeria at various times before the Second World War in the hope that it would afford a means both of increasing the yield of palm oil and of resisting some of the diseases to which the local West African oil palm is subject. It is reported that, over the first eight-year period, the local strains gave a much higher yield of fruit bunches than the Deli strains;

in fact, they outyielded them by about one-third. The superiority of the local strains seems to be increasing, as during the latter half of the period the difference in their favour was as much as two-thirds.

A comparison of the yields of the parent trees in Malaya with those of their progenies in the West African trial has shown an inverse relationship, the best trees in Malaya giving the poorest yielding progeny in Nigeria. Despite the generally poor showing of the Malayan Deli strains in the West African trial, one of them has done outstandingly well and is probably at least as good as, if not better than, the best Nigerian strain. The fruit and bunch composition of two leading strains is being studied in greater detail with the view of a breeding programme, and some of the preliminary data obtained are given. The authors conclude that the Deli palm is not well adapted to West African conditions, and, accordingly, the further introduction of Deli seed into West Africa for general planting is not recommended. There may, however, be certain already acclimatized strains as, for example, the Malayan Deli strain 19 × 65 in the aforementioned West African trial, which would repay exploitation for breeding purposes. Special characteristics of the Deli palm, such as disease resistance and dwarfness of growth habit, may also prove valuable.

---

# AGE OF URANINITES FROM BLIND RIVER, ONTARIO

By R. K. WANLESS and R. J. TRAILL
Geological Survey of Canada, Ottawa

As part of a continuing programme of the Geological Survey of Canada to date Canadian uranium deposits, two uraninite and three galena samples from the Blind River district of Ontario have been analysed chemically and by mass spectrometry. Ages of the uraninites have been determined using the lead : uranium, lead : thorium, and lead : lead ratios.

The Blind River region (Algoma district) in Ontario occupies a position of world importance as a uranium-producing area. In a period of two years following a prospecting rush in the area, six mines have been developed containing upwards of 150 million tons of ore at an average grade of between 2 and 2·5 lb. of $U_3O_8$ per ton[1].

Geological interest is widespread because of the similarities that exist between these deposits and the famous Witwatersrand deposits of South Africa. The mineralization, in each case, occurs in thin beds of quartz-pebble conglomerate which form part of a group of sediments overlying a complex assemblage of very old rocks. In both deposits, uraninite and gold have been reported in association with pyrite and minor amounts of other minerals, notably thucholite, monazite, zircon, rutile, galena, chalcopyrite and cobaltite. Brannerite is abundant locally in the Blind River deposits, but does not occur in the Witwatersrand conglomerates[2]. The origin of the Blind River mineralization is as controversial an issue as that of the Witwatersrand, and theories include the placer and hydrothermal concepts, and combinations of these.

Samples collected from the Pronto and Algom properties are described in Table 1. The galenas were concentrated from crushed drill-core samples using a Haultain superpanner. Microscopic examination revealed that the concentrates contained more than 95 per cent galena and less than 5 per cent pyrites and quartz. Radioactive assays indicated negligible radioactivity (less than 0·05 per cent $U_3O_8$ equivalent). Uraninite was concentrated from two high-grade hand specimens by superpanning and hand picking. The hand specimens were very similar macroscopically, and a mineragraphical study failed to reveal any differences in texture, grain size, and mode of occurrence of the uraninite. In both samples, the uraninite occurred as discrete angular grains, about 100 microns in diameter, in the pyritized matrix of quartz-pebble conglomerate. No other radioactive minerals were identified in the concentrates. Both concentrates contained about 10–15 per cent pyrites.

The isotopic abundances of the lead extracted from the uraninite and galena minerals were determined using a 90-degree Nier type mass spectrometer having a 10-in. radius of curvature. The sample was admitted to the instrument in the form of gaseous lead tetramethyl, and isotopic abundances were calculated from the tri-methyl ion currents in the 249–254 mass-range. The abundances quoted are the results of one or more mass spectrometric analyses, each consisting of at least ten repeat scans through the mass-range.

The lead isotope abundances are given in Table 1. Galena 1, from a non-radioactive zone, has a normal isotopic distribution whereas galenas 2 and 3, from

Table 1. Isotopic Abundance of Lead from Galena and Uraninite

| No. | Mineral | Location | $^{204}Pb$ | $^{206}Pb$ | $^{207}Pb$ | $^{208}Pb$ |
|---|---|---|---|---|---|---|
| 1 | Galena | Near Algom property, 1,500 ft. above ore zone in non-radioactive rocks | 1·42<br>1·00 | 24·30<br>17·11 | 22·67<br>15·96 | 51·61*<br>36·35† |
| 2 | Galena | Algom property in quartz-pebble conglomerate in ore zone | 1·06<br>1·00 | 36·04<br>34·00 | 15·99<br>15·08 | 46·92<br>44·26 |
| 3 | Galena | Algom property in cross-fraction in ore conglomerate | 0·76<br>1·00 | 45·21<br>59·49 | 14·14<br>18·61 | 39·89<br>52·49 |
| 4 | Uraninite | Algom Quirke Lake, 4th level east face | 0·10 | 86·15 | 8·19 | 5·56* |
| 5 | Uraninite | Pronto Uranium from underground drift | 0·33 | 81·42 | 9·82 | 8·43 |

* Isotopic abundance in per cent. † Isotopic abundance relative to $^{204}Pb$.

radioactive areas, have high radiogenic (lead-206, lead-207, and lead-208) lead abundances. Since a small lead-204 contribution was apparent in both uraninite samples a correction for common lead was required. Using the lead-204 abundance as an index of the amount of common lead present and the isotopic distribution of galena 1, a correction was applied to the uraninite abundances. This correction was based on the isotopic distribution of galena 1 for the following reasons: (1) galena 1 occurs in non-radioactive rocks adjacent to the Algom ore zone from which uraninite 4 was obtained; (2) the lead isotope abundances of galena 1 are of the same order of magnitude as those found for average ore lead of Precambrian age; (3) the best internal agreement between the ages determined from the lead : uranium, lead : thorium, and lead : lead ratios was obtained using galena 1 as a basis for correction.

The age determinations based on the lead-207 : lead-206, lead-207 : uranium-235, lead-206 : uranium-238, and lead-208 : thorium-232 ratios, listed in Table 3, indicate an average age of 1,300 million years for the Algom specimen and 600 million years for the Pronto uraninite. Since mineragraphical studies revealed no differences in the two hand specimens, and since both deposits occur in a pyritized formation which has been traced along strike for more than eighty miles, the determination of two distinct ages of uraninite mineralization is somewhat surprising. From the chemical values listed in Table 2 it is apparent that the lower age of the Pronto specimen results from the lower lead content, and that the uranium : thorium ratio for the two specimens is approximately the same. Loss of lead from pitchblendes (unpublished studies of the Geological Survey of Canada) has been held responsible for age variations in other deposits, and certainly the lead isotope abundances for galenas 2 and 3 (Table 1) illustrate the fact that radiogenic lead has been added to the original lead in these galenas. However, loss of lead from a radioactive sample produces a characteristic lead-207 : lead-206 ≫ lead-207 : uranium-235 > lead-206 : uranium-238 > lead-208 : thorium-232 age distribution between the ages calculated from the various ratios. Such a distribution is not found for the Blind River uraninites reported here. This study indicates that the uranium and thorium contents of the two uraninites are similar, and that the Algom uraninite is much older than the Pronto uraninite. Further study may, however, reveal more than one age of mineralization in both deposits.

Table 2. Partial Chemical Composition of Uraninite Concentrates

| No. | Uranium (per cent) | Thorium (per cent) | Lead (per cent) |
|---|---|---|---|
| 4 (Algom) | 43·8 | 3·6 | 10·7 |
| 5 (Pronto) | 48·3 | 4·5 | 5·2 |

Table 3. Age of Uraninites

| No. | Common lead correction | Age in millions of years $^{207}Pb/^{206}Pb$ | $^{207}Pb/^{235}U$ | $^{206}Pb/^{238}U$ | $^{208}Pb/^{232}Th$ |
|---|---|---|---|---|---|
| 4 (Algom) | Galena No. 1 | 1,170 | 1,300 | 1,400 | 1,265 |
| 5 (Pronto) | Galena No. 1 | 630 | 600 | 590 | — |

Preliminary mineralogical and isotopic studies indicate a complex history of mineralization in this region, and continuing studies based on selected, representative samples from all known radioactive occurrences are in progress. Considerable difficulty was experienced in obtaining sufficient material for analyses, and modifications to the experimental techniques are being carried out to permit isotopic determination on smaller samples.

We are indebted to the staffs of Algom and Pronto Uranium Mines, Ltd., for making the samples available for study. This communication is published by permission of the Acting Deputy Minister, Department of Mines and Technical Surveys, Ottawa.

[1] Joubin, Franc. R., *Amer. Inst. Chem. Eng.*, Preprint 286 (1955).
[2] Traill, R. J., *Can. Mining. J.*, **75**, 63 (1954).

# VIVIPAROUS CAECILIANS AND AMPHIBIAN PHYLOGENY

By Dr. H. W. PARKER
British Museum (Natural History), London, S.W.7

THE classical investigations of the Sarasins and of Marcus and his pupils into the embryology and development of the oviparous caecilians *Ichthyophis* and *Hypogeophis* have diverted attention from the fact that many of these little-known amphibians bear living young. This was first established as long ago as 1874, when Peters[1] recorded the occurrence of fœtuses in the oviducts of the species now known as *Typhlonectes compressicauda*. Since then, fœtuses have been reported in five other genera; but no one has determined whether the animals are merely ovoviviparous, retaining the eggs in the oviduct until ready to hatch, or whether nutritional material (embryotrophe) additional to the yolk of the egg is supplied by the mother.

Pregnant females of several species of four genera have been examined, and it is clear that the included yolk of each egg suffices for only a small part of the pre-natal growth and development. Several stages of pregnancy and the neonatal condition of *Geotrypetes* have been seen, and the sequence of events they reveal is as follows. The eggs are large, yolky and enclosed in a tough vitelline sphere just like the eggs of oviparous species. They are about 4 mm. in diameter and initially they are passed to the hinder end of the oviducts, where they lie in single file in contact with one another. Development proceeds inside the vitelline membrane until the fœtus is about 25 mm. long (mother 265 mm.), when hatching occurs. Until now the fœtus has been coiled, figure-of-eight fashion, over its yolk sac and has possessed long plumose external gills, three on each side with a short common stem. At the hatching stage the yolk mass has almost disappeared and the gills are in process of resorption. After rupturing the vitelline sphere, the embryos migrate in the oviduct and space themselves out equidistantly from one another throughout its length. They now lie fully extended, and by the time they have reached a length of 38 mm. the external gills have completely disappeared. Growth *in utero* continues and neo-natal specimens average 75 mm. in length. There is thus

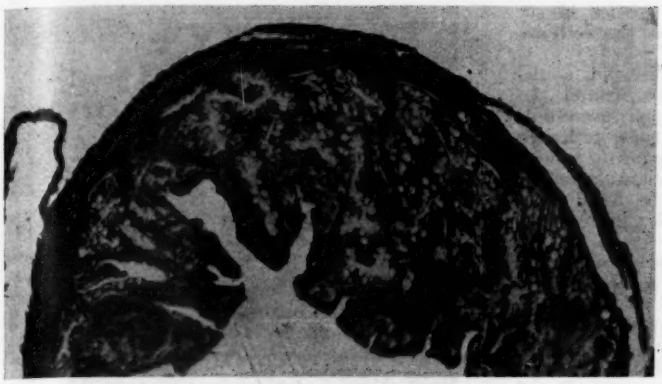


Fig. 1. *Schistometopum thomense.* Transverse section of anterior portion of pregnant oviduct, showing racemose glands and oil vacuoles. (× 90)

a 27-fold increase in mass after the initial yolk material is approaching exhaustion, and there must be some additional supply of nutritive material.

This general pattern may prove to be common to all the viviparous species. In the allied genus *Schistometopum*, fœtuses of 32–36 mm. have hatched and migrated and have no visible signs of yolk; their gills are small and asymmetrical and are presumably being resorbed. Fœtuses of 88–90 mm. (mother 257 mm.) are gill-less. Among the South American genera, gills (which are single and plate-like) are present in fœtuses of 59 and 62 mm. (*Chthonerpeton*) but wanting at a length of 110–120 mm. (*Gymnopis:* mother 405 mm.).

The mode of nutrition of the later fœtal stages is, as in many other anamniotes (cf. Matthews[2]), by means of 'uterine milk' ingested through the mouth. Many of the fœtuses examined had full stomachs, the material being mostly an amorphous non-cellular mass, but often containing a considerable amount of cellular debris and sometimes some recognizable erythrocytes. In the only fresh material seen (*Schistometopum*) the stomachs of the 88–90 mm. fœtuses contained a thick white creamy material consisting mainly of an emulsion of fat droplets, together with disorganized cellular material. This was clearly derived from the walls of the oviduct, which are richly provided with compound racemose glands lined by deep columnar epithelial cells the cytoplasm of which contains large oil globules (Fig. 1). It was also observed that the gall bladder in these fœtuses was relatively large and the contents of the hind gut were deeply coloured with bile.

The epithelium lining the lumen of the oviduct is highly vascular, with numerous capillaries lying within a few microns of the surface and thus fulfilling requirements for gaseous exchange. Correspondingly, the fœtal epidermis is nowhere more than two cells thick and is equally richly supplied with capillary blood vessels. The needs of the fœtus after loss of the gills are thus met by cutaneous respiration, but this must introduce a new problem for the animal. Such a delicate and highly vascular epidermis would be quite unsuitable for a burrowing life after birth. This difficulty appears to be overcome by sloughing the fœtal corneal layer immediately after parturition, coupled with a resting phase during which a new, thicker and tougher stratum corneum is proliferated. Newly born specimens of *Geotrypetes* have, in fact, been collected with their stomachs packed with their own sloughed cuticle one cell thick[3].

The caecilians thus exhibit no very novel departures from the method of viviparity occurring elsewhere among the anamniotes, but they do possess a feature that appears to be unique. There is a deciduous fœtal dentition. In all the fœtuses examined, the teeth are unlike those of the adult, both structurally and in arrangement. The teeth consist of two parts: a tubular pedicel and a crown with a hinged joint connecting the two (Figs. 2 and 4). The crown varies in shape from species to species and genus to genus; it may be spoon-shaped, with or without a single terminal cusp, spatulate and multicuspid or simple and recurved.

The teeth are arranged in multiple rows arranged quincuncially to produce a rasp-like structure, the number of rows varying on the different dentigerous elements of the skull and from species to species. (It is expected that a joint paper by the author and the late Prof. E. R. Dunn describing the various conditions in detail will be published soon.) The highest number of rows observed occurs on the nasopremaxillæ of *Chthonerpeton petersi*, where there are at least twelve; more usually, however, there are three or four rows (Fig. 2). The pedicels of the anterior rows are fused (Fig. 3) and the resulting plate is attached to the underlying dermal bone. This type of dentition has been found in fœtuses of every viviparous species examined. Nothing resembling it has been found in any free-living larva or in

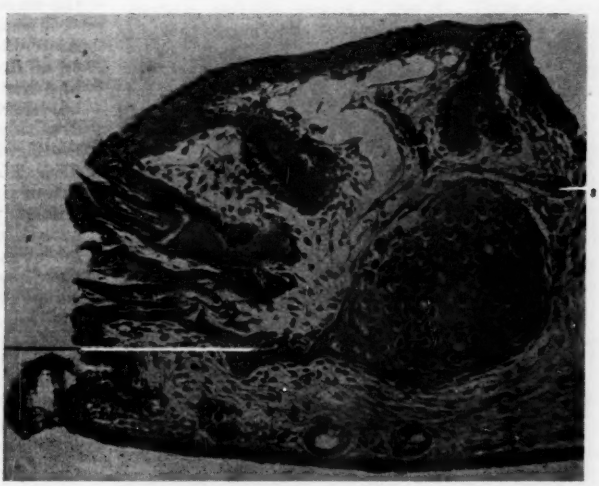



Fig. 2. *Chthonerpeton viviparum.* Paramedian section of fœtal lower jaw showing rows of hinged, pedicellate teeth associated with the dentary (*d*) and splenial (*s*) bones. (× 125)

the intra-capsular embryos of any species in six genera of oviparous caecilians; in these the teeth are like those of the adult.

The fœtal teeth are replaced by bicuspid, adult-type, teeth just before or just after parturition. In a very late (145 mm.) fœtus of *Gymnopis mexicanus mexicanus*, teeth are of the adult type, although younger fœtuses of the same subspecies have a typical rasp; on the other hand, newly born examples of *Geotrypetes seraphini* still have the fœtal rasp, although adult bicuspid teeth are also present but not attached to the bones.

Although there is a clear association between a special fœtal mode of nutrition and a special fœtal dentition, the latter can scarcely be an adaptation for the former. Apart from the apparent unsuitability of such a formidable rasp-like armament for ingesting milk, it is incredible that such an adaptation would have been developed more than once. So, all the species possessing it would represent a close phylogenetic assemblage. Yet any such taxonomic grouping cuts right across the systematic arrangements based on all other characters. For example, in American genera the gills are single and plate-like, but in the African forms they are triaxial and plumose; some genera are markedly zygokrotaphic, others slightly so, and one is completely stegokrotaphic. The only alternative explanation is that the fœtal dentition is an ancestral character that can persist only under conditions where teeth are not required and that has been suppressed as ineffective wherever a raptorial dentition is needed.

If this is indeed the explanation, it is not unreasonable to expect to find some traces of the ancestral condition elsewhere among the Amphibia, and this expectation is fulfilled. The amphibian tooth, both Urodele and Salientian, has two parts, pedicel and crown, separated, especially when young, by a washer of uncalcified tissue; these two parts, though not connected by a hinge, are clearly homologous with the two parts of the caecilian fœtal tooth. Further, the pedicels of Urodele and Salientian teeth fuse when they are in contact. Again, there are many instances, especially among the Urodela, of the teeth being arranged in multiple rows, and this occurs

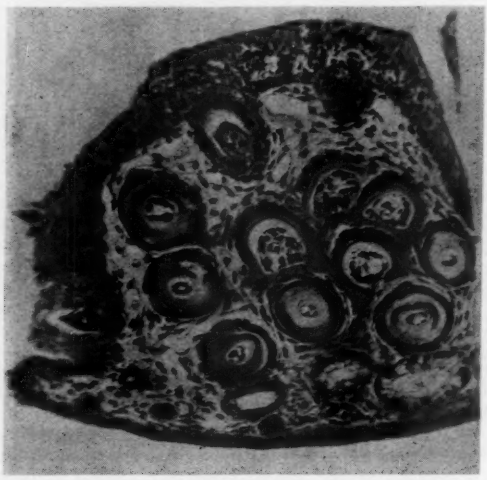


Fig. 3. *Chthonerpeton viviparum*. Transverse section of fœtal lower jaw, anterior to the symphysis, showing dental pedicels, some fused. (× 125)

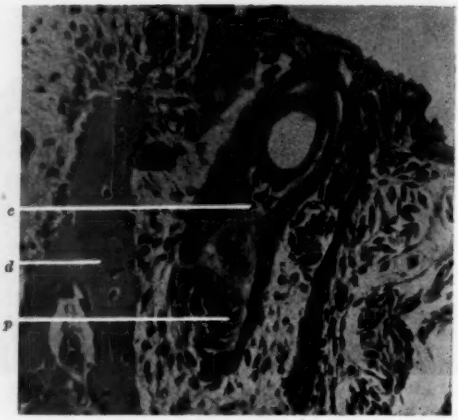



Fig. 4. *Schistometopum thomensis*. Vertical section through a developing spoon-shaped fœtal tooth of the dentary series. The pedicel (*p*) is developing in association with the crown (*c*) and not as an outgrowth of the dentary (*d*). (× 200)

most frequently among the permanently neotenic "Perennibranchiates". Examples are *Siren* with several rows on the vomers, palatines and splenials, and the axolotl, which manifests "The ichthyic character of rasp-like teeth, aggregated in numerous series . . . upon the palatal region of the mouth and upon the splenial or opercular element of the lower jaw" (Owen[4]). The Urodela also show a tendency towards multiplicity of teeth in the larval stage and a reduction at metamorphosis. Throughout the Salamandridae, for example, larvæ have a splenial with several rows of teeth that are all lost in the adult, and multiple rows on the vomer are reduced to one in *Salamandra* and *Amblystoma*. Newly born larvæ of *Salamandra salamandra* and uterine larvæ of *S. atra* have four rows of teeth on the dentary and, although it has been claimed that these represent merely a single 'functional' row with successional replacements, they are arranged quincuncially and the two outermost are 'functional' in the sense that both are fused to the bone.

It seems, therefore, that the ancestor of the recent Amphibia possessed numerous rows of hinged teeth on all dentigerous bones. Owen characterizes a rasp-like dentition as "ichthyic"; but however that may be, there can be little doubt that this ancestral dentition was associated with a different method of feeding, and probably a different, perhaps vegetarian, diet. The ancestral dentition persists to the greatest extent in the most primitive group, the Gymnophiona, when circumstances permit, and to a lesser extent in some of the Urodela. In this latter group, however, as in those caecilians with a free larval life, their predaceous, carnivorous habits have required complete, or almost complete, suppression of the multiple, hinged, teeth and their substitution by single rows of rigid teeth modified from the original pattern by elimination of the hinge and simplification of the crown. The horny dentition of the Anuran tadpole must be accounted a secondary feature developed in association with a further change in larval feeding habits.

[1] Peters, W., *Monatsber. Akad. Wiss. Berlin*, 45 (1874).
[2] Matthews, L. H., "The Comparative Endocrinology of Vertebrates", 1, "Comparative Physiology of Reproduction", 133 (1955).
[3] Parker, H. W., *Proc. Zool. Soc. London*, 1, 160 (1936).
[4] Owen, R., *Odontography*, 1, 189 (1840–45).

# DIMORPHISM IN THE PORTUGUESE MAN-OF-WAR

By A. H. WOODCOCK
Woods Hole Oceanographic Institution, Mass.

THE interesting problems of the sailing of *Physalia* have been revived by Totton and Mackie[1] and Fontaine[2]. Since the publication of my observations on the predominance of the left-sailing *Physalia* in the North Atlantic[3], I have had numerous opportunities to observe them in various parts of the world. These observations continue to show that North Atlantic animals are predominantly right-handed. Observations of *Physalia* in the North Pacific show similar results. Unfortunately, the southern hemisphere data are not yet extensive enough to test fairly my original suggestion that most of the animals on the southern seas may be mirror images of those in the northern hemisphere.

The purpose of this communication is to present and discuss these additional observations (see Table 1) and to discuss further the suggestions of Wilson[4] and of Totton and Mackie[1] concerning the role of wind direction in altering the 'landfall' possibilities of the two differently-sailing *Physalia*.

First, it should be pointed out that the original observations showing the dominance of the right-handed (left-sailing) *Physalia* in the northern hemisphere were made on the open sea. These data are not subject to the local wind-direction errors of beach observations, a fact which Totton and Mackie seem to have overlooked. Beached animals do, however, show a clear and similar dominance of right-handedness in the northern hemisphere when the local winds are nearly directly on shore. For example, compare observations 1, 2 and 3 in Table 1.

The greater number of the right-handed animals on the open sea does not necessarily indicate that this condition existed at the time the animals changed from the larval form. However, the numerical dominance of the right-handed animals, which was evident among the smallest of the *Physalia* found on a Florida beach (see Fig. 1 and Table 1), suggests that this dominance is present at the start.

These Florida observations, and many of those in Hawaii as well, indicate that the selective processes favouring the left-sailing animals begin very early in the life of the animal, if one supposes, with Totton and Mackie, "that in each brood of *Physalia* the two forms are produced in rough equality . . .".

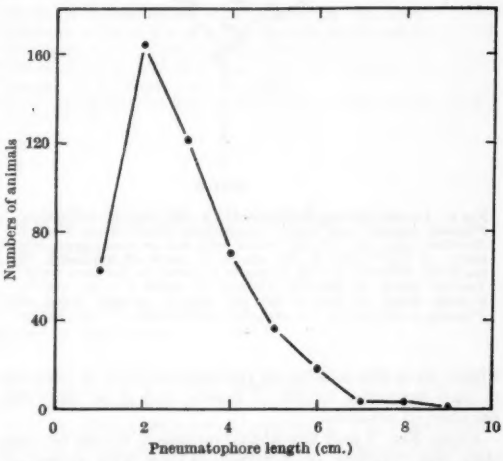



Fig. 1. A representative distribution of pneumatophore length among the *Physalia* seen during March, April and May 1944 on Ft. Pierce Beach, Florida. See Table 1 for total numbers

I have also measured roughly the sailing speed of a left-sailing North Atlantic *Physalia*, its angle of motion relative to the wind, and the approximate rate of down-wind drift of the upper 0·5 cm. of surface water. My results are about the same as those of Totton and Mackie, and are illustrated in Fig. 2.

Note in this figure that the number of animals which can land in unit time and on a unit length of beach (*H*) depends upon the angular relationship between their sailing-course line (for example, line *BC*) and the beach line (*H*). These lines control the angle $\alpha$, and the length of line *A*. Thus the sine of the angle equals the ratio of the total possible landings on a section of beach (*H*) to the observed landings. This relationship is expressed in the following equation, and may be applied to all *Physalia* where $\alpha$ is known.

$$N_e = \frac{1}{\sin \alpha} N \qquad (1)$$

Table 1. OBSERVATIONS OF THE NUMBER OF RIGHT-HANDED (LEFT-SAILING) AND LEFT-HANDED (RIGHT-SAILING) *Physalia* SEEN ON THE SURFACE OF THE OPEN SEA AND ON VARIOUS SHORES. THE 'AT SEA' DATA INCLUDE THE ORIGINAL OBSERVATIONS FROM REF. 3

| Data No. | Name | No. observed | | Date | Location | Ratio of right-sailers to left-sailers | Average on-shore wind angle* | Position | | Place name |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Right-handed | Left-handed | | | | | Lat. | Long. | |
| 1 | *Physalia physalis* L. | 159 | 3 | 1939–45 | at sea | 0·02 | — | 25°–40° N. | 46°–80° W. | North Atlantic |
| 2 | *Physalia physalis* L. | 344 | 9 | 1942 | at sea | 0·03 | — | 26°–28° N. | 84°–89° W. | Gulf of Mexico |
| 3 | *Physalia utriculus*, Esch.† | 824 | 29 | 11/51–7/52 | on beach | 0·04 | 80–100 | 21° 23·5′ N. | 157° 43′ W. | Hawaii |
| 4 | *Physalia physalis* L. | 1,625 | 66 | 3/44–5/44 | on beach | 0·04 | 60–80 | 27° 18′ N. | 80° 13′ W. | Ft. Pierce, Florida |
| 5 | *Physalia utriculus*, Esch. | 694 | 0 | 18/12/51 | on beach | 0·00 | 90 | 21° 23·5′ N. | 157° 43′ W. | Hawaii |
| 6 | ? | 314 | 306 | 8/52 | on beach | 0·98 | 45 | 33° 45·2′ S. | 151° 17·9′ E. | Deewhy Beach, Sydney, Australia |

* The 'average on-shore wind angle' is measured in a counter-clockwise direction from a line parallel to the beach.
† From ref. 5.

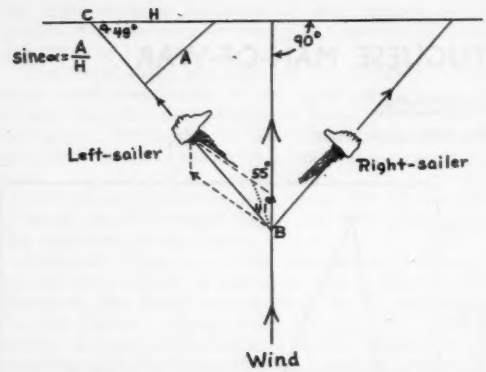



Fig. 2. Average sailing performance of a right-handed, left-sailing *Physalia physalis*, and further suggestions about effects of wind direction upon the number which will sail on to a shore (see text). A right-sailer is also shown in order to emphasize its markedly different sailing course in response to the same wind. Average speed of topmost 0·5 cm. of water = 9 cm. sec.$^{-1}$; average speed of wind = 680 cm. sec.$^{-1}$; average speed of *Physalia* = 26 cm. sec.$^{-1}$; pneumatophore length 17 cm., height 7 cm.

where $N_e$ is the maximum possible number of arrivals in unit time and length of beach, and $N$ is observed number of arrivals.

From Fig. 2 and the above equation it can be seen that the number of arrivals of the two forms of *Physalia* on a beach will represent the relative distribution on the sea only when the wind angle is 90° and the sailing angles $\alpha$ are equal.

The very small *Physalia*, such as most of those observed in Florida (see Table 1 and Fig. 1), sail much more slowly than the large *Physalia*. Their sailing course, assuming the same angular relationship to the wind as the large animal, would tend, therefore, to approach the shore at an angle which more nearly equalled that of the wind. For example, an animal sailing at one-fourth speed would follow a course from *B*, Fig. 2, shown by the dotted line. This may explain why the ratio of the right to the left-sailers on the Florida beach (see Table 1, observation 4) was so similar to this ratio among those observed on the open sea, despite the occasional obliquity of the wind.

On Lanikai Beach, Oahu, Hawaii, the north-east trade wind was almost always blowing from the sea and nearly normal to the beach. Hence the relative number of the two types of animals observed on this beach, as given in Table 1, observation 3, should represent their relative distribution on the open sea. During one exceptional period of several days, however, southerly or 'Kona' winds occurred, producing off-shore winds on the lee side of Oahu which carried the normal *Physalia* population far out to sea. Thus the lee side of the island became a 'shadow zone' for right-sailers (Fig. 3). For a period of about a day after the shift from southerly winds to the normal 'trades' occurred, only left-sailing *Physalia* were seen on the beach (see observation 5, Table 1). This result is explicable as illustrated in Fig. 3, the Kaiwi Channel producing a local separation of the two forms. (For convenience, equal numbers of lines are shown representing the differing sailing courses of the two forms during south-south-west winds. It is not intended to imply that an equality of number of the two forms exists at sea.) The first left-sailing *Physalia* to reach Lanikai beach after the wind shift to the north-east would presumably come from point *A*, while the first right-sailer would sail a greater distance from point *B*. Assuming the same sailing speed and sailing direction relative to the wind as that of the Atlantic *Physalia* (Fig. 2), the difference in the arrival time of *Physalia* from these two points would be about thirteen hours and may account for the observed complete dominance of the left-sailers among the first arrivals on the beach after the wind shift.

Observation 6, in Table 1, was made on the southern end of Deewhy Beach, Sydney, and seems to support the idea that most of the southern hemisphere animals sail to the right of the wind. On the only day when I was free to walk on the beach and to observe the stranded *Physalia*, the average wind angle was about 45° to the general trend of the irregular coast line of this region. According to equation (1), very few right-sailers should have been found on Deewhy Beach, since the angle $\alpha$ for the right-sailers would in this case become 4°, and the sine about 0·07. Actually, about one-half of the animals seen were right-sailers. These Deewhy Beach observations, when 'corrected' for the effects of the average sailing angle on the number of the right-sailers arriving on the beach, suggest a dominance of this form on the open sea of about ten to one of the left-sailers. This ratio agrees roughly with that among the southern hemisphere museum specimens discussed in the previous paper[3].

The above 'correction' is open to the serious objection that it is made using the sailing characteristics of the somewhat larger North Atlantic *Physalia*, which are given on Fig. 2. Also, in common with all beach observations of stranded animals, there are the added questions about the effects of coastal currents, and of changes in wind direction which may have occurred after they sailed ashore and before I arrived at the beach to observe them. It is hoped that someone will soon test these rather unsatisfactory southern hemisphere data by direct observation on the open sea in the Sydney region or elsewhere.

If further work proves the existence of a world-wide difference of *Physalia* form and sailing performance in the two hemispheres, we shall wish to know to what extent various physical factors may have produced this difference. Will such dominance of one form in each hemisphere be due to ecological factors acting selectively on each generation, to established genetic differences, or perhaps to 'tack' changes

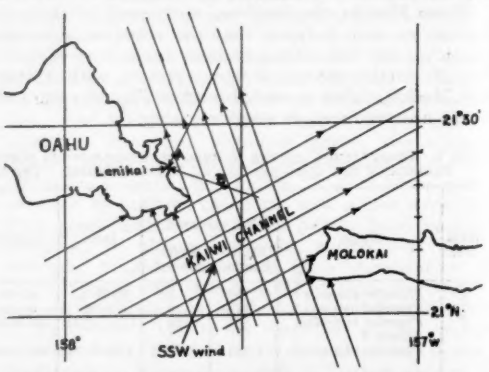



Fig. 3. Assumed separation of left-sailing and right-sailing *Physalia* in passing through Kaiwi Channel before a south-south-west wind. Note that the lee side of the islands is, in varying degree, a 'shadow zone' for either one or both forms. Following a wind shift to the normal east-north-east trades, the first animals of the two forms arriving on Lanikai Beach would sail different distances, along the new course lines shown, from points approximating intersections *A* and *B*

caused by migration of the tentacles on the pneumatophore? The answers to these questions will be interesting and perhaps useful in further studies.

My earlier proposal concerning a possible selective influence of small-scale wind-induced eddy motions in the surface waters[3] still seems reasonable to me. Larger-scale wind and water motions may be important, however. It is worth noting here that left-sailing *Physalia* in the average anti-cyclonic wind systems of the North Atlantic and the North Pacific[6] will move away from the centres of the systems, and often in the direction of coastal waters. The average wind systems of the oceans of the southern hemisphere tend to be cyclonic[6]. In cyclonic wind systems a right-sailer will also tend to sail away from the centres of the systems and in some cases toward coastal areas.

I am convinced that there is much that oceanographers can learn about the surface waters of the seas from detailed studies of the sailing of *Physalia*.

I am indebted to my young son, John B. Woodcock, for his enthusiastic help in collecting observations in Hawaii.

[1] Totton, A. K., and Mackie, G. O., *Nature*, **177**, 290 (1956).
[2] Fontaine, A., *Notes Nat. Hist. Soc. Jamaica*, **64**, 61 (1954).
[3] Woodcock, A. H., *J. Marine Res.*, **5**, 196 (1944).
[4] Wilson, D. P., *J. Mar. Biol. Assoc.*, **27**, 139 (1947–48).
[5] Bonnet, D. D., *Science*, **103**, 148 (1946).
[6] "Atlas of Climatic Charts of the Oceans", U.S. Wea. Bureau., Wash., D.C. (1938).

# STIMULATION OF COLEOPTILE- AND ROOT-GROWTH BY EXTRACTS OF MAIZE

By S. HOUSLEY*, A. BOOTH and I. D. J. PHILLIPS
Botany Department, University of Manchester

PAPER chromatography of the acidic ether-soluble material in plant extracts has revealed the presence of several growth-promoting and -inhibiting substances in a range of plant material[1] including roots and shoots[2,3]. One promoter, termed accelerator-α, has been shown[3,4] to enhance the growth of both roots and coleoptiles above that of a control at certain concentrations, yielding in the case of roots a characteristically shaped activity curve (similar to Fig. 3). Accelerator-α, an ether-soluble substance[5], possibly does not normally occur in plants[6]; but is thought to be formed during the preparation of plant extracts for chromatography from other compounds which occur in the aqueous ether-insoluble portion of extracts[5]. With tomato roots[6] this aqueous material, after chromatography on paper with ammoniacal *n*-butanol and bioassay with coleoptile sections, gives three zones of growth promotion. At least two of these zones, if eluted from the paper individually and then rechromatographed in the same solvent system on a new paper, result in chromatograms with the same pattern of growth promotion, showing that some of the active substances on the chromatograms may be converted readily from one to another. The present work reports the occurrence of similar compounds in maize and describes their effect upon the growth of cress roots.

Coleoptiles (703 gm.) and roots of four-day old maize seedlings (a dent-type derivative from Rhodesian 'White Salisbury' commercially termed 'African Giant Horse Tooth Hybrid') grown in the dark at 25° C. were quickly frozen, coarsely comminuted, and extracted separately in 1·5 l. ether at −5° C. and natural *p*H (approximately 5·5) for 4 hr. Protein was precipitated from the aqueous ether-insoluble fraction with ethanol (2 vol. absolute : 1 vol. aqueous fraction) and centrifuged off, and the alcoholic remainder distilled under reduced pressure to an aqueous syrup (34·7 gm. coleoptile extract) at a bath temperature of 40° C. The extracts were stored at −15° C. Paper chromatography was carried out in *n*-butanol saturated with 1·5 *N* ammonia; details of the chromatographic technique and of chromogenic spray reagents are described elsewhere[5], except for the Salkowski reagent (1 ml. 0·5 *M* ferric chloride + 50 ml. 35 per cent perchloric acid). The methods of bioassay with coleoptile sections of oats (Victory)[7] and roots of cress[5,6] have been reported previously. In the cress test, test solutions were pipetted on to filter paper in Petri dishes and were not incorporated into agar as previously described[5]. All means are derived from ten replicates, except in Figs. 3 and 4, where the number is shown above the standard error or mean.

Chromatography of the coleoptile aqueous syrup (0·33 gm., equivalent to 7·2 gm. fresh weight, on an 18 cm. starting line) in *n*-butanol/ammonia usually results in a histogram with four peaks (Fig. 1); but there may be less (Fig. 2, 0·74 gm. syrup on a 19 cm. line); similar results are obtained with corresponding extracts of roots. Although activity in the roots and coleoptiles is rather low compared with tomato roots[6], it is consistently present. Unpublished work by Mr. G. Britton in these laboratories has shown that these zones of growth promotion behave in a manner similar to those of tomato roots[6] when they are rechromatographed.

Results obtained with chromogenic sprays on chromatograms of coleoptile extracts are shown in Fig. 1. With roots, the chromogenic pattern with the same sprays was very similar except that the $R_F$ values were smaller, and *p*-dimethylaminobenzaldehyde gave a more intense purple reaction ($R_F$ 0·13–0·21) and ferric chloride/perchloric acid a yellow reaction in the same zone: in this respect it is of interest that $R_F$ values may be influenced considerably by the viscosity of the aqueous syrup and the quantity loaded on a chromatogram. No evidence was obtained of the presence of 3-indolylacetic acid on any chromatogram. Ether-soluble material of the coleoptile and root extracts was also chromatographed, bioassayed and examined with chromogenic sprays; again, no evidence of the presence of 3-indolylacetic acid was obtained.

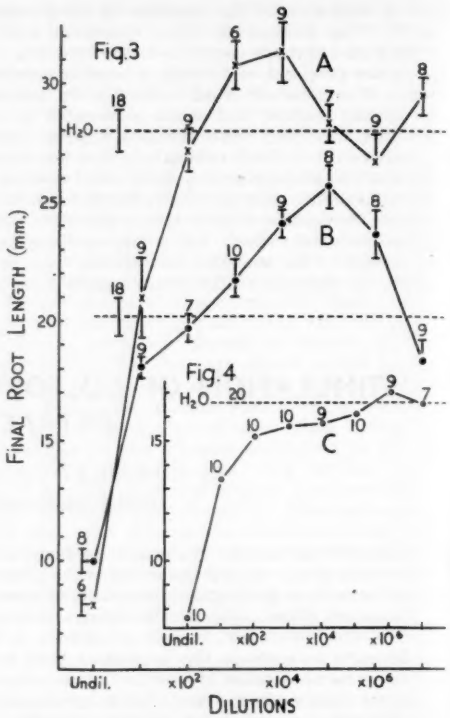
To examine the effect of growth promoters in the aqueous ether-insoluble fraction on the growth of roots, chromatograms were prepared in a manner similar to that used for Fig. 1 and a longitudinal strip

* Present address: Horticultural Department, Colworth House, Sharnbrook, Bedford.

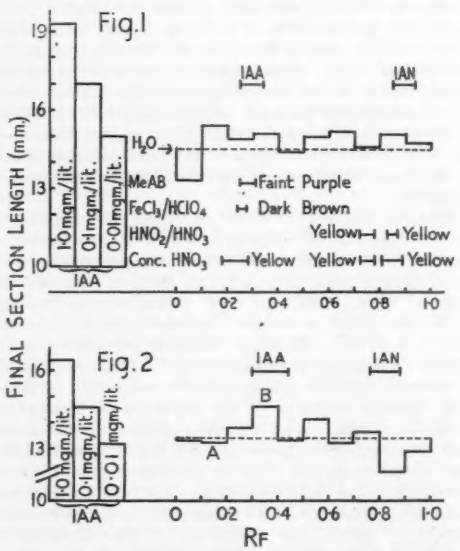
bioassayed with coleoptile sections. The remainder was stored dry in the dark at −15° C. for 24–48 hr. until the $R_F$ values of the active zones were known; these, between the limits of $R_F$ 0 and 0·5, were then cut out of the stored portion, eluted with water and tested on cress roots. In some tests activity curves similar to *A* and *B* (Fig. 3) were obtained, whereas in others curves similar to *C* (Fig. 4) were given. Other data of interest were obtained when certain zones of a maize coleoptile chromatogram (Fig. 2) were tested on cress roots before the result of the corresponding oat assay was known. It is seen that in addition to the active zone *B*, the inactive zone *A* has stimulated root growth above a water control (Fig. 3, *B* and *A* respectively). Two other zones of the chromatogram were also tested ($R_F$ 0·6–0·7 and 0·8–0·9); both gave curves similar to *C* in Fig. 4.

To account for these results, in which enhanced coleoptile- and root-growth may occur in the same zone or in different zones of chromatograms, it may be suggested that there were two chemically distinct types of growth-inducing substances present in the extracts, one auxin-like[6] inducing coleoptile-growth and the other, possibly hormonal[5] but not auxin-like, inducing root-growth. On the other hand, there may be a closer chemical relationship between these substances, and conversion from one to the other has to occur before enhanced root-growth can be obtained. The present data, including those of zone *A* in Fig. 2 in which conversion could have occurred before chromatography was carried out, may be interpreted equally well by either hypothesis and further work is required before a firmer opinion can be expressed.

The inability to detect free 3-indolylacetic acid in coleoptiles and roots of maize seedlings confirms other unpublished work carried out at Manchester on maize in which no indolylacetic acid has been found in the plant except in the fruit. This absence of indolylacetic acid is of particular interest in growth studies, for it




Figs. 3 and 4. Activity curves of cress roots (initial length 5 mm.). Curves *A* and *B* were obtained from eluates taken from zones *A* and *B* of the chromatogram of Fig. 2. Curve *C* was obtained from the eluate of a zone of a maize root chromatogram (not shown) corresponding to $R_F$ 0·1–0·2 in Fig. 1




Figs. 1 and 2. Chromatography in *n*-butanol/ammonia of the aqueous ether-insoluble fraction of extracts of maize coleoptiles. The $R_F$ of marker spots of 3-indolylacetic acid (IAA) and 3-indolylacetonitrile (IAN), and the response of oat coleoptile sections (initial length 10 mm.) in solutions of IAA are shown. MeAB = *p*-dimethylaminobenzaldehyde

has been long held that it is the sole or principal auxin in plants and that in roots it is present at supra-optimal concentrations. However, from the present studies and others in progress at Manchester, we have been led to question these views. On chromatograms of aqueous ether-insoluble extracts and on many chromatograms of ether-soluble materials, active zones of coleoptile elongation cannot be systematically associated with the chromogenic reactions given by those reagents generally used for indole detection. This and other evidence available at the present time suggests that in the plant there are other hormonal substances besides 3-indolylacetic acid controlling growth, the chemical nature of which may be non-indole.

We thank Prof. S. C. Harland for generous facilities in the Department of Botany, and Drs. P. F. Wareing and R. Pecket and Mr. J. Hannay for constructive criticism and valuable discussion. The work was supported by grants to two of us (A. B. and I. D. J. P.) by the Department of Scientific and Industrial Research.

[1] Nitsch, J. P., and Nitsch, C., *Beit. Biol. Pflanz.*, **31**, 387 (1955).
[2] Bennet-Clarke, T. A., and Kefford, N. P., *Nature*, **171**, 645 (1953).
[3] Lexander, K., *Physiol. Plantarum*, **6**, 406 (1953).
[4] Kefford, N. P., *J. Exp. Bot.*, **6**, 245 (1955).
[5] Housley, S., and Bentley, J. A., *J. Exp. Bot.*, [7, 219 (1956)].
[6] Britton, G., Housley, S., and Bentley, J. A., *J. Exp. Bot.*, [7, 239 (1956)].
[7] Bentley, J. A., and Housley, S., *Physiol. Plantarum*, **7**, 405 (1954).
[8] Moewus, F., *Biol. Zentral.*, **98**, 118 (1949).
[9] Tukey, H. B., Went, F. W., Muir, R. M., and van Overbeek, J., *Plant Physiol.*, **29**, 307 (1954).

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Drift Experiments with Radioactive Pebbles

An experiment on the detection of movement of pebbles on the sea bed was carried out off Scolt Head Island in Norfolk during April and May 1956. Pebbles marked radioactively were used for this purpose. It is believed that it is the first time that such a method has been used in Britain to trace pebbles.

In each pebble, a hole ¼ in. deep and ⅛ in. diameter was made. It was found that local flint from the beach was very difficult to drill, and a compromise had to be made by using pebbles of Permian Sandstone, with a few flints only, and also a number of pebbles made of cement. The pebbles averaged about 2 in. in major diameter and were all rounded. The specific gravity of the pebbles averaged 2·4, which is about 0·2 less than that of flint. In all, some twelve hundred were used.

The radioactive tracer used was barium-140, an isotope with a half-life of 12 days, which decays by beta-emission and low-energy gamma-radiation into lanthanum-140 (half-life 40 hr.). The lanthanum emits a series of gamma-rays of which the principal has an energy of 1·6 MeV., and it was these gamma-rays which were used for detection under water.

For loading the pebbles, pure barium-140 was used to avoid health hazard from the gamma-rays. The lanthanum-140 activity, which was negligible during loading, then built up to a maximum in about five days, after which it was almost in equilibrium with the barium-140 and decayed with an effective half-life of 12 days. About 15 microcuries of barium-140 was adsorbed to each of twelve hundred resin particles, and one of these was placed in each pebble and sealed with a resin-based adhesive.

In this experiment, three Geiger counter tubes with a sensitive length of 60 cm. were enclosed in a brass cylinder of 1 metre in length. The cylinder was mounted on a heavy metal sledge. The sledge was towed along the sea bed over an area of several hundred yards around the dumping position on each search. In the boat was a rate-meter, connected to the tubes in the cylinder by a multicore cable. The detector was capable of 'finding' a pebble at a distance of about twelve inches under water.

On April 5 the pebbles were all dumped at the same moment from a boat at a point some 500 yd. seaward from normal high-water mark off Scolt Head, in water varying in depth between 12 ft. and 25 ft., depending on the state of the tide. Throughout most of the time of the experiment the depth of water over the main dump of the pebbles was of the order of 16–20 ft. The shallowest depth of 12 ft. was only recorded at low-water springs and the greatest depth at high-water springs. The floor on which the pebbles were to be dumped was hard and consisted of shingle and sand. The place had been marked with a buoy which was placed 20 yd. farther seawards of the dump so that when detecting operations were carried out the buoy ropes should not foul the detecting apparatus. The position of the buoy was fixed by intersection from angles measured by theodolite and sextant from three fixed points on the island. The position of the stones was fixed by sextant angles from the boat to those points on the land. The weather at the time the pebbles were dumped was squally, and the following night there was a wind reaching force 5–6. It was impossible to make any further observations until April 8. On that day, clear records were found of some of the pebbles having moved southwards and a little west up to a distance of 200 ft. Further searches were made on April 9, 12, 20 and 23 and on May 5 and 15. The results obtained on all these dates were generally consistent and showed clearly that a number of pebbles had moved and continued to move very slowly in a direction slightly west of south, that is, inshore. The maximum movement was of the order of 260 ft. In addition, observations made on May 15 showed that some pebbles had also moved north and west, one definite record being found about 450 ft. north-west of the original dump. It may have been that this north-westerly movement had occurred previously, and was only found on May 15; but this seems unlikely since the area had been swept over on each search. It should be appreciated that the detecting apparatus sweeps a band only one metre wide, and therefore a considerable time is needed to sweep even a small area of sea bed, and it is impossible to guarantee that every square yard of a given area has been searched.

Nevertheless, the results show that in ordinary weather, with a few squalls but no true storms, pebbles can be moved along the sea floor. Waves during this period are not likely to have exceeded 3 ft. in height. The flood current in this part of Norfolk flows west, and the ebb to the east. The maximum speed of the flood at springs is about 2½ ft./sec. It seems unlikely that the current itself can move pebbles of this sort; but it might certainly work in with wave action and help to do so.

This experiment was designed to work out a technique for the use of radioactive tracers in determining underwater movement of coarser beach material. If the method can be perfected, it will give a very important aid to coastal physiographical study.

C. Kidson
The Nature Conservancy.

D. B. Smith
U.K. Atomic Energy Authority,
Isotope Division,
Harwell.

J. A. Steers
Department of Geography,
University of Cambridge.
June 1.

## Radiation-induced Changes in Reactivity of Bovine Fibrinogen

The acute effects of total body irradiation on mammalian hæmostasis are now well established[1]. Information concerning direct effects on individual clotting components is meagre, and in the case of fibrinogen is confined to observations following the application of doses of X-rays of such high magnitude as to have no practical significance in the field of mammalian radiation damage[2,3]. The present study of fibrinogen is therefore concerned with the direct influence of low doses of irradiation.

Purified bovine fibrinogen (lot No. 55199) was generously supplied by Dr. E. C. Loomis, of Parke, Davis and Co., and was shown to contain 90–93 per cent clottable protein. Solutions of this fibrinogen (3 mgm./ml.) in 0·15 *M* sodium chloride buffered

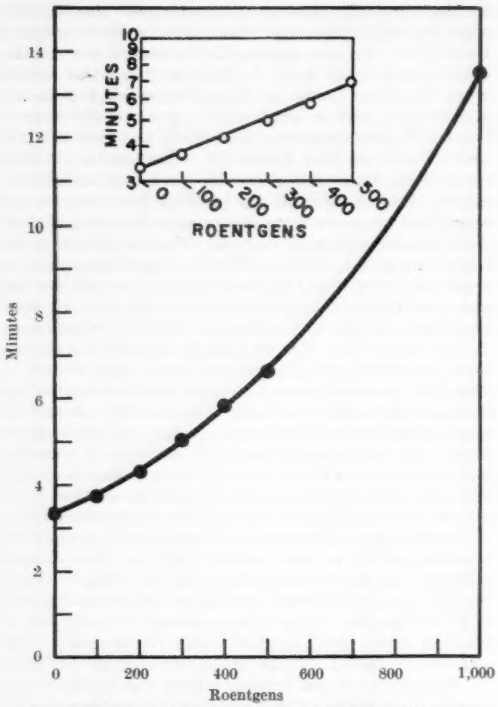



Fig. 1. Firm-gel clotting-time of irradiated bovine fibrinogen. (Inset: semi-logarithmic plot of data)

with imidazole at *p*H 7·4 were exposed to single X-ray doses, and the firm-gel time of a 0·3-ml. sample upon the addition of 0·05 ml. containing 1/16 unit of purified bovine thrombin was determined at 37·5° C. As Fig. 1 shows, the clotting time was increased with increasing X-ray dosage in the range of 100–500 r. and above. A similar relationship was obtained in the range of 25–100 r. The clotting delay was found to be independent of the fibrinogen concentration from 1 mgm./ml. to 5 mgm./ml., but was proportional to the thrombin concentration in the range of 0·063–0·5 units, at which point the clotting delay was abolished.

The clotting delay was accompanied by an alteration of the firm-gel characteristics. The rate of solution in 5 *M* urea of fibrin clots obtained from irradiated fibrinogen was accelerated. Apparently, irradiation alters some of the links which bind together the units of fibrin so that they become more readily accessible to the action of urea.

In view of the above influence of X-rays on final gel structure it appeared desirable to test the effect of sulphydryl compounds, since sulphydryl groups may play a part in firm-gel production[4]. Addition to fibrinogen, prior to irradiation, of solutions of $10^{-3}$ *M* cysteine or glutathione failed to alter the radiation-induced clotting defect but prolonged the clotting time in both the irradiated and unirradiated solutions. Thioglycollic acid ($10^{-3}$ *M*), as well as higher concentrations of cysteine ($10^{-3}$ *M*), completely inhibited the clotting process in both the irradiated and control solutions. These findings do not exclude the possibility that the polymerization phases of the clotting process are dependent on sulphydryl, since Scheraga and Nims[2], using very high doses, found that cysteine protects radiation-sensitive sites in the fibrinogen molecule.

The foregoing changes are also accompanied by a significant reduction in the release of fibrinopeptide during the clotting of irradiated fibrinogen (500 r.). Using the method of Lorand[4], a value of 3–4 per cent peptide split was obtained from unirradiated samples; in contrast, 30 per cent less peptide was liberated after irradiation. Despite this reduction in the thrombin-induced release of fibrinopeptide, the amount of clottable protein or the ratio of clottable/total protein in the fibrin clot remained unchanged.

From the above it follows that the radiation-induced defect in clotting does not simply lead to an inactivation of the fibrinogen molecule but to a specific alteration. If it is assumed that the exposure of charged sites as a consequence of the release of peptides results in the formation of linear polymers, then the reduction in peptide liberation provides an adequate explanation of the decreased rate of clotting. The observation, however, that the characteristics of the firm gel are also altered may reflect a dependence of the terminal processes on the extent of peptide release.

The specific modification(s) in the fibrinogen molecule induced by low doses of radiation may represent a mechanism of interaction between radiation and biologically active proteins. This may be of importance with regard to generalized radiation damage.

We wish to thank Messrs. J. L. Weatherwax and L. Stanton, of the American Oncologic Hospital, for the use of the X-ray apparatus. This work was carried out while one of us (P. R.) was working under U.S. Atomic Energy Commission contract *AT*(30–1)–1554.

Peter Rieser
Robert J. Rutman

Department of General Physiology,
Zoological Laboratory,
University of Pennsylvania,
Philadelphia 4, Pa.
March 1.

[1] Upton, A. C., *Blood*, **10**, 1156 (1955).
[2] Scheraga, H. H., and Nims, L. F., *Arch. Biochem. and Biophys.*, **36**, 336 (1952).
[3] Edsall, J. T., "Blood Cells and Plasma Proteins", 133 (Academic Press, New York, 1953).
[4] Lorand, L., *Biochem. J.*, **52**, 200 (1952).
[5] Bettelheim, F. R., *Biochim. et Biophys. Acta*, **19**, 121 (1956).

## Paper Electrophoresis of Rat Pancreatic Juice and Water-Soluble Proteins of the Pancreas

Electrophoretic fractionation of pancreatic juice components in a dog has been described in the literature[1–4]. Some of the authors[2,3] isolated part of the fractions and studied their enzymatic activities. All authors used the free electrophoresis method with the exception of Delcourt and Delcourt[4], who employed paper electrophoresis for the separation of the different fractions.

As part of a general study of the synthesis of proteins of rat pancreas, pancreatic juice was analysed by means of paper electrophoresis. It was collected for three hours after a secretin-carbamoylcholine stimulus, as described by Junqueira, Hirsch and Rothschild[5], at 0° C. The electrophoresis of 10-μl. samples of pancreatic juice (average protein content, 6 per cent) was performed on Whatman No. 1 filter

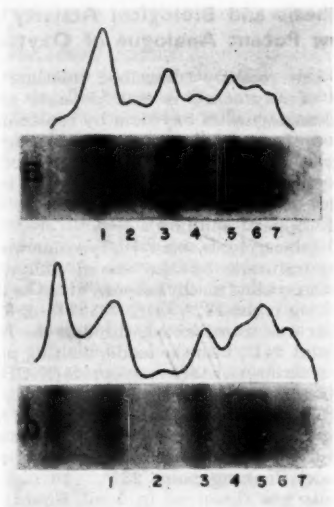



Fig. 1. *a*, Electrophoretic pattern of the rat pancreatic juice. 1—amylase; 2—ribonuclease; 3—proteolytic activity (trypsin) plus esterase and lipase activity; 5—proteolytic activity (chymotrypsin). *b*, Electrophoretic pattern of the water-soluble proteins of the rat pancreas. 1—amylase; 2—ribonuclease; 3—proteolytic activity plus esterase and lipase activity; 5, 6, 7—proteolytic activity

paper strips during 20 hr. at room temperature. Veronal-acetate buffer of *p*H 8·6, ionic strength 0·1, was used with a current of 110 V. 0·5 mA. per cm. in electrophoresis apparatus (No. 3276, L.K.B., Stockholm). Six or seven fractions could be separated in these conditions (Fig. 1*a*). A part of the paper was stained for proteins with amido black 10 *B*[6] and the other part cut into corresponding fractions, eluted with a suitable buffer and tested for their enzymatic activity. No lipoproteins or periodic acid–Schiff reagent-positive substances could be detected in the ionographs.

Amylolytic activity, as assayed by the method of Smith and Roe[7], was found to be associated only with fraction 1. The maximum of ribonuclease activity, determined by Rabinovitch's modification of the method described by Kunitz[8], was present in fraction 2. Residual activity could be detected in fractions 1 and 3. Lipase and esterase activity, measured by the method of Seligman and Nachlas[9], using β-naphthyllaurate as substrate, with and without taurocholate, was found to be associated with fraction 3, with little residual activity in the adjacent fractions. Esterase activity was also demonstrated directly on the paper, applying the histochemical method of Nachlas and Seligman, as modified by Gomori[10], using α-naphthylacetate as substrate. Proteolytic activity, as assayed by the Kunitz casein method[11], was found in fractions 3 and 5. Since trypsin, as well as chymotrypsin, are measured by this method, trypsin inhibitors such as ovomucoid and the soy-bean inhibitor were used, in order to distinguish the two enzymes. About 80 per cent inhibition was obtained with ovomucoid in fraction 3 and 40–50 per cent in fraction 5. The soy-bean inhibitor had a more marked effect. The results suggest that trypsin is probably associated with fraction 3 and chymotrypsin with fraction 5.

An interesting fact is that proteolytic activity appears without the addition of an activator, whereas this does not occur in fresh pancreatic juice. There is probably an autoactivation during the time of the electrophoretic run. This activation is, however, partial. On adding an activator, such as trypsin, to the different fractions, proteolytic activity appears in addition to bands 3 and 5, and also in the fast-moving bands 6 and 7. This suggests that the precursors of the proteolytic enzymes, namely, trypsinogen and chymotrypsinogen, may be located there.

Water-soluble proteins of rat pancreas, obtained from a centrifuged (40 min. at 15,000 *g*) 20 per cent aqueous homogenate of the pancreatic tissue, were subjected to paper electrophoresis as described above, using 30-μl. samples of the solution. A similar number of fractions as for the pancreatic juice was obtained (Fig. 1*b*), with an additional fraction that remained at the origin under the experimental conditions used. Amylase activity is associated with fraction 1; ribonuclease activity with fraction 2; esterase and lipase activities with fraction 3. Autoactivation of the proteolytic enzymes was only exceptionally observed. When activated with trypsin, proteolytic activity appeared in the fast-moving bands and also in fraction 2, instead of fraction 3, as in the case of the pancreatic juice.

HANNA A. ROTHSCHILD
L. C. U. JUNQUEIRA

Laboratory for Cell Physiology,
Faculdade de Medicina,
Universidade de São Paulo.
Feb. 1.

[1] Munro, M. P., and Thomas, J. E., *Amer. J. Physiol.*, **145**, 140 (1945).
[2] Byrne, G. M., Phinney, J. I., Schachter, M., and Young, E. G., *J. Biol. Chem.*, **192**, 683 (1951).
[3] Grossberg, A. L., Komarov, S. A., and Shay, H., *Amer. J. Physiol.*, **168**, 269 (1951).
[4] Delcourt, A., and Delcourt, R., *C.R. Soc. Biol.*, **147**, 1104 (1953).
[5] Junqueira, L. C. U., Hirsch, G. C., and Rothschild, H. A., *Biochem. J.*, **61**, 275 (1955).
[6] Grassmann, W., and Hannig, K., *Hoppe-Seylers Z. physiol. Chem.*, **290**, 1 (1952).
[7] Smith, B. W., and Roe, H. J., *J. Biol. Chem.*, **179**, 53 (1949).
[8] Rabinovitch, M., *Proc. Soc. Exp. Biol. Med.*, **85**, 685 (1954).
[9] Seligman, A. M., and Nachlas, M. M., *J. Clin. Invest.*, **29**, 31 (1950).
[10] Gomori, G., "Microscopic Histochemistry", p. 206 (University of Chicago Press, 1952).
[11] Kunitz, M., *J. Gen. Physiol.*, **30**, 291 (1947).

## Comparison of the Metabolic Stimulating Action of Aspirin and Thyroid

SALICYLATE is a powerful metabolic stimulant in animals (Reid, J., personal communication, 1952), in man[1] and in tissue slices[2]. In hypothyroid patients it is possible to restore the basal metabolic rate to normal levels with dosage of the order of 8 gm. aspirin daily in divided doses.

Comparison of the effects of aspirin and thyroid (given seriatim) in two cases of myxœdema shows that they possess several actions in common: both cause increased oxygen consumption, decrease in the serum cholesterol, and hæmodilution. Since many features of myxœdema which have been attributed to the low metabolic rate (for example, slow cerebration) are unaffected by aspirin, the question arises as to whether the type of metabolic stimulation produced by aspirin and that by thyroid can be similar.

Fig. 1 shows a dose-response curve for thyroid extract in myxœdematous patients, constructed from data of Means and Lerman[3]. At each dose-level the drug was given for a prolonged period, until a constant effect was obtained. This constant basal metabolic rate is taken as the effect of the given dose.

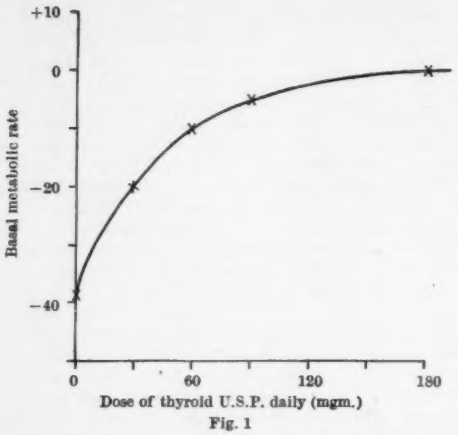
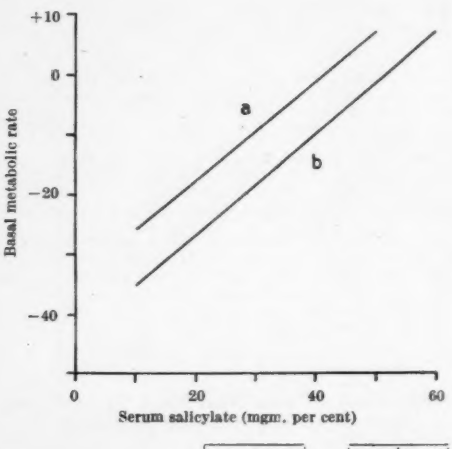



Fig. 1

Fig. 2 shows the serum salicylate-level plotted against basal metabolic rate in two female patients (*a*, age 65 years; *b*, age 43 years) with classical primary myxœdema. A similar linear relationship is obtained when dose of salicylate is used instead of serum-level.




| | *a* | *b* |
|---|---|---|
| Number of observations | 15 | 13 |
| Correlation coefficient | 0·931 | 0·944 |
| Value of *P* | <0·001 | <0·001 |

Fig. 2

The dissimilarity in the dose-response curves obtained with thyroid and with aspirin suggests that though they both produce metabolic stimulation, it is not of the same kind.

Details of this work will be published later.

W. D. Alexander
K. W. M. Johnson

Clinical Chemotherapeutic Research Unit
(Medical Research Council),
Western Infirmary,
Glasgow, W.1.
Feb. 2.

[1] Cochran, J. B., *Brit. Med. J.*, ii, 964 (1952).
[2] Sproull, D. H., *Brit. J. Pharmacol.*, **9**, 262 (1954).
[3] Means, J. H., and Lerman, J., *Arch. Int. Med.*, **55**, 1 (1935).

## Synthesis and Biological Activity of a New Potent Analogue of Oxytocin

Using the recently described method for the synthesis of oxytocin[1], it was possible to prepare structural analogues of oxytocin by replacing the isoleucyl group by valyl, leucyl or phenylalanyl groups. Of the series obtained, the valyl analogue of oxytocin ('valyl-oxytocin') was the most active and interesting substance. A description of its synthesis and some biological properties follow:

N-CBO-S-benzyl-L-cysteinyl-L-tyrosine was coupled in tetrahydrofurane by the mixed anhydride procedure with L-valine methylester to give the tripeptide ester, melting point 132°, $[\alpha]_D^{25} - 36°$ (*c*. 2·9 in methanol). This was transformed, through the hydrazide, melting point 241°, into the azide, melting point 110°, which, by reaction with the hexapeptide (N-CBO-L-glutaminyl-L-asparaginyl-S-benzyl-L-cysteinyl-L-prolyl-L-leucyl-glycinamide) gave the nonapeptide (N-CBO-S-benzyl-L-cysteinyl-L-tyrosyl-L-valyl-L-glutaminyl-L-asparaginyl-S-benzyl-L-cysteinyl-L-prolyl-L-leucyl-glycinamide), melting point 232°. 20 mgm. of the nonapeptide was dissolved in 5 ml. liquid ammonia and reduced with sodium[2]. 5 mgm. of ammonium chloride was added; the ammonia was evaporated and the residue added to 100 ml. of water, the *p*H adjusted to 6·8, carbon-dioxide-free air bubbled through the solution for 2 hr., and the *p*H adjusted to 4·5. By this procedure the cyclic octapeptide was obtained.

This solution of 'valyl-oxytocin' was assayed by several methods, the international post-pituitary standard powder being used for comparison throughout. The tests used included the blood pressure in the chicken (sodium phenobarbitone anæsthesia)[3], the isolated rat uterus[4], the isolated cat uterus, the milk ejection pressure of the rabbit mammary gland (urethane anæsthesia)[5], the rat uterus *in situ* (urethane anæsthesia), the cat uterus *in situ* (chloralose urethane anæsthesia)[6], the anti-diuresis in non-anæsthetized rats[7] and the blood pressure in spinal cats.

The effect on the blood pressure in the chicken and on the isolated rat uterus was equivalent to that of 3 I.U./ml. These two methods usually recommended for the assay of oxytocic preparations therefore produced identical results. However, by measuring the milk ejection pressure of the rabbit mammary gland, which has been claimed to be the most sensitive test for oxytocin[5], the effect was equivalent to that of 15 I.U./ml. This figure was surprising, since synthetic oxytocin exerted identical effects in all three tests.

The remarkable difference between the effect on the isolated rat uterus and blood pressure in the chicken, on one hand, and on the milk ejection pressure of the rabbit mammary gland on the other, necessitated further investigation. On the cat uterus *in situ*[6] the effect was equivalent to that of 16 I.U./ml., whereas on the cat uterus *in vitro* it was equivalent to that of 6 I.U./ml. A similar difference was also found in experiments on rats; whereas the effect on the isolated uterus was equivalent to that of 3 I.U./ml., the effect on the uterus *in vivo* was approximately equivalent to that of 10 I.U./ml.

Finally, the anti-diuretic and pressor activity was investigated. In non-anæsthetized rats 'valyl-oxytocin' had an anti-diuretic effect equivalent to that of 0·03 I.U./ml. In spinal cats its pressor activity was approximately equivalent to that of 0·015 I.U./ml. Therefore, the relationship between the pressor activity and the uterine activity of 'valyl-oxytocin' is even more in favour of the uterine activity

than is the case with natural and synthetic oxytocin[5,6].

These results show that for 'valyl-oxytocin': (1) there is good correlation between the effect on the blood pressure in the chicken and that on the isolated rat uterus; (2) the effect on the milk ejection pressure of the rabbit mammary gland bears no correlation to the effect on the blood pressure in the chicken and the effect on the isolated rat uterus; (3) there are great differences between the effect on the uterus *in vitro* and on the uterus *in situ* of the same species (rats and cats); (4) there are distinct species differences in sensitivity (rats and cats).

These findings suggest that synthetic compounds with oxytocin-like properties should be tested not only on the isolated rat uterus and on the blood pressure of the chicken but also on a much larger battery of tests to define their characteristics.

Extensive investigation into the chemistry, pharmacology and clinical activity of 'valyl-oxytocin' and related compounds is being pursued, and the results will be published in detail elsewhere.

R. A. Boissonnas
St. Guttmann
P.-A. Jaquenoud
J.-P. Waller

Laboratory of Organic and
Pharmaceutical Chemistry,
University, Geneva,
and
Department of Pharmaceutical Chemistry,
Sandoz, Ltd.,
Basle.

H. Konzett
B. Berde

Department of Pharmacology,
Sandoz, Ltd.,
Basle. May 18.

[1] Boissonnas, R. A., Guttmann, St., Jaquenoud, P.-A., and Waller, J.-P., *Helv. Chim. Acta*, **38**, 1491 (1955).
[2] du Vigneaud, V., Ressler, Ch., Swan, J. M., Roberts, C. W., and Katsoyannis, P. G., *J. Amer. Chem. Soc.*, **76**, 3115 (1954).
[3] Coon, J. M., *Arch. Int. Pharmacodyn.*, **62**, 79 (1939).
[4] Holton, P., *Brit. J. Pharmacol.*, **3**, 328 (1948).
[5] van Dyke, H. B., Adamsons, K., and Engel, S. L., "Rec. Prog. Hormone Res.", **11**, 1 (1955).
[6] Konzett, H., Berde, B., and Cerletti, A., *Schweiz. Med. Wschr.*, **86**, 226 (1956).
[7] Burn, J. H., Finney, D. J., and Goodwin, L. G., "Biological Standardization", 188 (Oxford Univ. Press, 1950).

## *In vivo* Inhibition of Oxidative Phosphorylation of Rat-liver Mitochondria by 2 : 4 Dinitrophenol

In a recent publication, Dianzani and Scuro[1] claimed that the oxidative phosphorylating capacity of mitochondria isolated from various rat tissues was greatly decreased 20 hr. after intraperitoneal injection of 2 : 4 dinitrophenol. The inhibition of P/O ratios from the mitochondria was 60 per cent; from kidney, 54 per cent; from heart, 51 per cent; and from skeletal muscle, 87 per cent.

Changes such as these are difficult to reconcile with the existing knowledge of the mode of action of 2 : 4 dinitrophenol. Like 3 : 5 dinitro-ortho-cresol[2], 2 : 4 dinitrophenol is an acute poison which, by intravenous or intraperitoneal injection, either kills an animal in 2–3 hr. or is followed by complete recovery in the next few hours. Further, this compound can be injected daily without any increase in susceptibility[3,4]. It has also been shown that *in vitro* inhibition of oxidative phosphorylation may be reversed by washing[5,6].

Table 1

| No. of animals | Treatment | Oxygen uptake ($\mu$moles) | Inorganic phosphate uptake ($\mu$gm. atoms) | P/O ($\pm$ S.D.) |
|---|---|---|---|---|
| 5 | None | 3·39 $\pm$ 0·59 | 7·91 $\pm$ 2·0 | 2·36 $\pm$ 0·26 |
| 5 | Dinitrophenol* | 3·56 $\pm$ 0·60 | 8·23 $\pm$ 1·0 | 2·35 $\pm$ 0·26 |
| 3† | Dinitrophenol* | 3·83 $\pm$ 0·92 | 8·92 $\pm$ 2·4 | 2·32 $\pm$ 0·20 |

* Intraperitoneal injection of aqueous solution of 2 : 4 dinitrophenol at 3 mgm./100 gm. body weight.
† Mitochondria isolated in sucrose.
Mitochondria prepared as in Aldridge and Cremer (ref. 7).
Each manometric flask contained: mitochondria equivalent to 250 mgm. fresh tissue; 0·02 *M* sodium phosphate buffer, *p*H 7·4; 0·001 *M* adenosine monophosphate; 0·0067 *M* magnesium sulphate; 0·025 *M* potassium chloride; 0·00001 *M* cytochrome *c*; 0·033 *M* glucose; 0·0167 *M* sodium fluoride and 300 units of yeast hexokinase ('step 3' purity, according to Berger *et al.* (ref. 8)), 0·5 ml. 30 per cent perchloric acid in side-arm. Total vol. 3·5 ml. Temperature 25° C. Gas phase, air. Potassium hydroxide in centre. Equilibrium for 7 min. followed by measurement of oxygen uptake for 10 min. Reaction stopped by tipping acid from side-arm. Phosphate on deproteinized fluid by Fiske and Subbarow (ref. 9).

In view of the importance ascribed to oxidative phosphorylation in energy metabolism and the relevance of these observations to the toxicology of 2 : 4 dinitrophenol and related compounds confirmation of Dianzani and Scuro's experiment was sought. Table 1 shows that there was no significant difference between the oxidative phosphorylative capacity of mitochondria isolated from the livers of normal rats and that of mitochondria from rats previously injected with 2 : 4 dinitrophenol. As during the preparation of these mitochondria they were washed with potassium chloride, a further experiment was made in which the mitochondria were isolated entirely in 0·25 *M* sucrose. Again no difference could be detected. Finally, six rats were each injected with 3 mgm. 2 : 4 dinitrophenol/100 gm. body weight on each of five successive days. These animals survived the experiment.

The discrepancy between these results and those of Dianzani and Scuro awaits elucidation.

V. H. Parker

Toxicology Research Unit,
Medical Research Council Laboratories,
Woodmansterne Road,
Carshalton, Surrey.
April 27.

[1] Dianzani, M. U., and Scuro, S., *Biochem. J.*, **62**, 205 (1956).
[2] Parker, V. H., Barnes, J. M., and Denz, F. A., *Brit. J. Indust. Med.*, **8**, 226 (1951).
[3] Magne, H., Mayer, A., and Plantefol, L., *Ann. Physiol. Physiochim. Biol.*, **8** 1 (1932).
[4] Schultze, T. C., and Tainter, M. L., *Proc. Soc. Exp. Biol., N.Y.*, **21** 1163 (1937).
[5] Brody, T. M., and Bain, J. A., *J. Pharmacol.*, **110**, 148 (1954).
[6] Loomis, W. F., and Lipmann, F., *J. Biol. Chem.*, **173**, 807 (1948).
[7] Aldridge, W. N., and Cremer, J. E., *Biochem. J.*, **61**, 406 (1955).
[8] Berger, L., Slein, M. W., Colowick, S. P., and Cori, C. F., *J. Gen. Physiol.*, **29**, 379 (1946).
[9] Fiske, C. H., and Subbarow, Y., *J. Biol. Chem.*, **66**, 375 (1925).

## An Estimation of the Nature of Nucleoproteins by an Analytical Method

In previous publications[1,2] we have shown that a very constant relationship exists between the amount of deoxyribonucleic acid and the amount of arginine in the nucleus of an erythrocyte; we found the ratio 5·0 in the erythrocytes of all the species we studied (trout, pike, carp, tench, perch, barbel, roach). In the case of spermatozoa of some of these species, we found that this ratio is not the same as in erythro-

cytes. When the sperm contains a typical protamine (trout, pike), the ratio deoxyribonucleic acid/arginine is 1·6; in other cases (carp, tench) this ratio approximates to 5·0, just as in somatic nuclei.

A similar analytical study was performed with bovine species—on isolated calf thymus nuclei and on bull sperms; it was shown that the ratio 5·0 was found in the case of the somatic nucleus (thymus) and the ratio 1·48 in the case of sperm. This result led us to think that the bull sperm probably contains a protein rich in arginine, that is, a protein of the protamine type. The nature of the protein linked to the deoxyribonucleic acid in bull sperm, and that in the sperm of other mammals, is not known for certain, for the routine methods for the extraction of nucleoproteins cannot be applied to such material. We thought that an indication of the nature of the spermatogenetic modifications of the protein linked to deoxyribonucleic acid might be given (at least in many cases) by a simple determination of the deoxyribonucleic acid/arginine ratio. This method would need but minute quantities of biological material, and could be applied to small animals, for example, insects. In order to test the validity of this hypothesis, we applied our analytical procedure to a case recently studied by Daly *et al.*[3]. These authors isolated a nucleoprotamine from rooster sperm, and a histone from the nuclei of erythrocytes. Using our analytical method, we were able to confirm these data. Expressing our results per nucleus, we found for the rooster's erythrocyte, $2{\cdot}2 \times 10^{-6}\gamma$ of deoxyribonucleic acid and $0{\cdot}45 \times 10^{-6}\gamma$ of arginine. The ratio deoxyribonucleic acid/arginine is thus 4·88. In sperms, on the contrary, we found $1{\cdot}10 \times 10^{-6}\gamma$ of deoxyribonucleic acid and $0{\cdot}78 \times 10^{-6}\gamma$ of arginine per sperm, the ratio being 1·41. This result indicates the possibility of the presence in rooster sperm of a protamine rich in arginine, which is in a good agreement with the data of Daly *et al.*

Summarizing, the study of the ratio deoxyribonucleic acid/arginine could afford a rapid procedure for an extensive study in living species of the nature of the nuclear protein linked to the deoxyribonucleic acid in the nuclei, in order to determine whether a general process exists in the biochemistry of the formation of male gametes.

A. Knobloch
R. Vendrely

Centre de Recherches
sur les Macromolécules,
Strasbourg.
April 27.

[1] Vendrely, R., and Vendrely, C., *Nature*, **172**, 30 (1953).
[2] Vendrely, C., Knobloch, A., and Vendrely, R., *Biochim. Biophys. Acta*, **19**, 472 (1956).
[3] Daly, M. M., Mirsky, A. E., and Ris, H., *J. Gen. Physiol.*, **34**, 439 (1951).

## Serotonin and Connective Tissue

Serotonin (= 5-hydroxytryptamine = enteramine) has been demonstrated in carcinoids of the small intestine as well as in the blood and urine of patients suffering from this disease[1]. The symptoms of these conditions are ascribed to the release of serotonin to the blood and tissues[2]. They consist primarily in cutaneous vasomotor signs (flushing), tachycardia, asthma-like dyspnœa and hyperperistalsis. Right-sided heart disease with tricuspid and pulmonal valvular lesions are noted in some but not in all cases. In prolonged cases pulmonary stenosis appears to be a fairly constant sign. Firm connective-tissue masses have been found to envelop the pelvic organs, as well as the iliac and hypogastric arteries. Considerable masses of connective tissue have also been observed deep to the cardiac valves, and microscopic examination has revealed connective tissue proliferation[3]. Articular swelling has been observed[2]. Hedinger and Gloor[3] mention the possibility that carcinoids and their metastases may secrete a substance stimulating connective-tissue formation.

It has been suggested that serotonin might act as a histamine-liberator substance, some of the clinical signs resembling a histamine effect[4]. Various histamine liberators are able to induce degranulation and disruption of tissue mast cells[5].

Since connective-tissue formation is invariably initiated by an accumulation of mast cells believed to produce important ground-substance components and to contain histamine, the effect of serotonin upon mast cells was studied.

Living connective tissue with intact circulation was studied in the cheek pouch of the hamster under nembutal anæsthesia by a method previously described[6]. Unstained living cells were studied in the phase-contrast microscope fitted with a water immersion lens and a warm stage. Mast cells stained with an aqueous solution of toluidine blue, 1 per mille, were studied in the bright-field microscope. By the last-mentioned method, the mast-cell granules stain metachromatically, indicating a content of mucopolysaccharides. Physiological saline was used as the immersion fluid.

Serotonin creatinine sulphate (National Biochemical Corp.), injected intraperitoneally in doses of 1 and 2 mgm., induced pronounced œdema of the connective tissue, and the animals showed signs of respiratory impairment as well as cyanosis of the muzzle and paws. A pronounced degranulation of the mast cells was observed within 10–20 min. When the metachromatic granular substance was no longer demonstrable in the mast-cell body, a basic structure resembling a sponge or a honeycomb was left in the cells, which were otherwise intact. Irreparable breakdown of the cells was observed only in exceptional cases.

The connective tissue formation caused by carcinoids and their metastases may be related to the degranulating effect of serotonin upon the mast cells. The tissue œdema induced by this agent is supposed to be primary to the release of water-binding mucopolysaccharides from the cells.

This work was aided by grants from Eli Lilly and Co., Indianapolis, Indiana, the Danish Anti-Cancer League, and the National Danish Association against Rheumatic Diseases.

G. Asboe-Hansen
O. Wegelius*

Connective Tissue Research Laboratory,
Institute of Medical Anatomy,
Copenhagen.
June 16.

* Home address: Maria Sjukhus, Helsinski.

[1] Pernow, B., and Waldenström, J., *Nord. Med.*, **55**, 100 (1956).
[2] Waldenström, J., and Ljungberg, E., *Acta Med. Scand.*, **152**, 203 (1955).
[3] Hedinger, C., and Gloor, R., *Schweiz. Med. Wchnschr.*, **84**, 942 (1954).
[4] Feldberg, W., and Smith, A. N., *Proc. Physiol. Soc.* (1953).
[5] Riley, J. F., *J. Path. and Bact.*, **65**, 471 (1953).
[6] Wegelius, O., and Asboe-Hansen, G., *Acta Physiol. Scand.* (in the press).

## A Substance promoting Hatching and Liberation of Young in Cirripedes

DURING their passage through the oviducal tract, the eggs of barnacles appear to be mixed with a sticky secretion. Eggs removed directly from the ovaries remain separate; but those extruded from the oviducal openings cohere in strings, and eventually clump together, forming the paired egg masses. These are at first soft and gelatinous, but gradually become firmer, presumably because the secretion binding them together hardens. There is a clearly visible membrane surrounding each mass of eggs. Though when first formed each egg-mass is joined loosely to the oviducal opening, this connexion is transient and the egg masses lie freely in the mantle cavity for practically the whole of their development. Therefore, barnacles, unlike other Crustacea which retain eggs, need not lose them during the casting of the integument, nor is ecdysis a necessary part of the process by which embryos are discharged into the sea. Casting can and does occur regularly in many species while the eggs are still retained in the mantle space[1].

Egg masses are often retained for a considerable period after reaching their final stage in development[2], and throughout this period they will hatch only if removed from the parental mantle cavity and broken up in sea water. Although the mantle cavity is in direct communication with the sea and must exchange sea water freely when the barnacle feeds, hatching evidently takes place only when the individual eggs have access to sea water. They cannot hatch when in the centre of a mass of eggs, either because it is mechanically impossible or perhaps because the oxygen supply is too limited to allow the vigorous hatching movements to take place[3]. Natural hatching in all species studied is preceded by a breaking down of the egg masses into a soft pulp of separated eggs. These leave the mantle space in the jet of water forced out during the normal cirral beat between the last pair of cirri and the carina. Hatching usually occurs to some extent in the mantle space itself; but many unhatched eggs, some still clumped in small groups, are usually expelled with the freely swimming larvæ.

Aqueous extracts of tissues comprising mantle wall or body, but not of egg masses themselves, were found to stimulate liberation. If gravid barnacles were placed in such extracts liberation was sometimes induced within 10 min. The extracts clearly influenced the egg mass itself, not the parent barnacle, since equally rapid hatching and breakdown of isolated egg masses could be observed in watchglasses containing the extracts. Preliminary experiments showed the active principle to be heat-stable and non-specific.

It was noted that individuals of *Balanus balanoides* containing fully developed eggs which were kept in well-aerated sea water in the laboratory, but not fed, did not liberate their young at the normal time. The egg masses remained coherent and in some instances, particularly in those individuals maintained at temperatures exceeding 10° C., began to decompose in the mantle cavity. If the barnacles were fed, whether on animal or plant food, liberations took place normally within one or two days. This behaviour suggests the secretion of an active substance following the ingestion of food, perhaps the same substance that could be extracted from the tissues.

This response to food would normally delay the liberation of young until conditions were suitable for their nutrition. Thorson[4] has postulated a similar behaviour in other arctic forms, notably lamellibranchs. It might explain why the southern boundary of *B. balanoides* coincides with the March isotherm of sea temperature[5]. Too high a temperature in winter would accelerate development, and the eggs might be ready to hatch while there was scarcely any planktonic food available. If the temperature remained too high during this period the basal metabolism of the fully developed embryos might rise beyond the point at which sufficient oxygen could diffuse into the egg mass for its survival.

Liberation in response to feeding might also explain the limitation of this species to estuaries in Cornwall, Brittany and other places at the southern limit of its range[6]. The greater amount of detritus might provide sufficient food to stimulate barnacles growing in these estuaries to liberate their nauplii earlier and so avert the risk of embryonic suffocation.

In an environment where high temperature is limiting, this mechanism of liberation may render the species ill-adapted, so that a small difference in nutrition would have an important influence on distribution. In the arctic, where temperatures may be low all the year round, and where the season of plankton production is short, liberation of young in response to improved nutrition would be obviously advantageous.

D. J. CRISP

Marine Biology Station,
University College of North Wales,
Bangor.
May 3.

[1] Crisp, D. J., and Clegg, D. J. (unpublished observations).
[2] Crisp, D. J., and Davies, P. A., *J. Mar. Biol. Assoc. U.K.*, **34**, 357 (1955).
[3] Crisp, D. J., *J. Mar. Biol. Assoc. U.K.*, **33**, 473 (1954).
[4] Thorson, G., *Medd. Komm. Havundersøg., Kbh.*, Plankton, **4**, 1, 424 (1946).
[5] Hutchins, L. W., *Ecol. Monogr.*, **17**, 325 (1947).
[6] Southward, A. J., and Crisp, D. J., *J. Anim. Ecol.*, **23**, 163 (1954).

## Production of Patulin in Apple Fruits by *Penicillium expansum*

IT has been thought unlikely that antibiotics are produced under natural conditions, (*a*) because the necessary nutrients would not usually be available and (*b*) because other micro-organisms might be expected to compete for nutrients and, in some cases, to destroy metabolically any antibiotic formed. Nevertheless, a plant parasite may have access to a relatively rich nutrient supply and may be, in early stages of an infection at least, isolated from the influence of other micro-organisms. *Penicillium expansum* is an unspecialized plant parasite, causing storage rots of apples; most freshly isolated strains produce the antibiotic patulin (synonyms: clavacin, expansine) in suitable culture media. We thought it of interest to see whether it produces patulin in apple tissues.

A strain of *P. expansum* known to produce patulin in culture was found to produce an antibiotic in apple tissues. The antibiotic had the same spectrum of antimicrobial activity as patulin, and its behaviour on paper chromatograms, using three different solvent systems, was the same as that of patulin. There seems no reason to doubt that it was, in fact, patulin. Its concentration in sap expressed from rotted tissues

at times reached high levels; concentrations of the order of 600–1,000 mgm./l. (by bioassay) were found in rots of Bramley's Seedling apples. We have also found that sap from natural rots caused by *P. expansum* frequently contains an antibiotic with the antimicrobial spectrum of patulin. Thus the antibiotic patulin is produced under natural conditions, and, in view of the importance of *P. expansum* as an apple pathogen, probably in considerable quantities.

The known phytotoxic properties of patulin suggested that it might play a part in the production of rot symptoms. Strains of *P. expansum* which produce little or no patulin in culture media also produced no detectable quantities in apple fruits and yet caused equally vigorous rots. Thus it seems unlikely that patulin is concerned in pathogenesis. We hope to deal with this point more fully, in a later publication, and to consider at the same time the role of pectic enzymes. However, it is interesting to speculate whether the production of such substances as patulin, fusaric acid[1] and alternaric acid[2] in plant tissues by fungal parasites may not to some extent discourage secondary invaders, preserving territory, as it were, for the primary parasite.

P. W. Brian
G. W. Elson
D. Lowe

Akers Research Laboratories,
Imperial Chemical Industries, Ltd.,
Welwyn, Hertfordshire.

[1] Lakshminarayan, K., and Subramanian, D., *Nature*, **176**, 697 (1955).
[2] Brian, P. W., Elson, G. W., Hemming, H. G., and Wright, J. M., *Ann. App. Biol.*, **39**, 308 (1952).

## Response of Animal Fibres to Acid Attack

The stress–strain curves given by a wide range of animal fibres in air or water are practically alike, apart from differences in the low-strain region due to the presence of crimp. It has now been observed that even closely similar wools can exhibit substantial differences in the mechanical properties of their fibres, and corresponding differences in solubility in alkali, after exposure to chemical attack, such as boiling acid solution.

Such differences had been found to exist earlier among keratin fibres from different animal species[1]; but their occurrence between wools from the same type of sheep was unexpected.

The two wools used in these studies were closely similar in mean diameter (21·9 and 22·1μ, respectively), but differed in their crimp-level (14·8 and 8·9 crimps/in. in the staple). Samples of clean intact wool were treated under reflux with 100 vol. of boiling 0·04 *N* sulphuric acid for various times, following the procedure used earlier in this laboratory[1,2]; the alkali solubility was then determined, and the rate-constants for the acid-sensitizing reaction calculated, assuming two concurrent first-order reactions, by fitting the equation

$$\text{wool}_t = F_o e^{-k_o t} + F_p e^{-k_p t}$$

where $\text{wool}_t$ is the fraction of wool found insoluble in the alkali-solubility test after $t$ hours of exposure to acid. The '*o*' fraction presumably corresponds to the ortho portion of the fibre cortex, and the '*p*' to the para[1]; but this is not of primary importance to the present work. The results obtained are given in Table 1.

Table 1

| Wool | $F_o$ | $k_o$ | $F_p$ | $k_p$ |
|---|---|---|---|---|
| High crimp | 0·513 | 0·377 | 0·408 | 0·0440 |
| Low crimp | 0·521 | 0·458 | 0·408 | 0·0830 |
| *P* | | 0·05 | | <0·001 |

Both rate constants are greater for the low-crimp wool, indicating that it is more susceptible to acid attack.

Force-extension tests to break were made on the Instron tensile tester at 70° F., in aqueous borate buffer, *p*H 9·2, at a constant rate of extension[3] of 50 per cent/min.; eighteen fibres were examined for each wool in the intact state and after two exposures to acid. The results for two mechanical properties of the fibres, together with the corresponding alkali-insolubility values, are reported in Table 2.

Table 2

| Time in acid (hr.) | Alkali-insolubility | | | Elastic modulus (gm./cm.²) × 10⁻⁴ | | | Breaking energy (gm.·cm./cm.²) × 10⁻⁴ | | |
|---|---|---|---|---|---|---|---|---|---|
| | High cr. | Low cr. | *P** | High cr. | Low cr. | *P** | High cr. | Low cr. | *P** |
| 0 | 93·4 | 94·1 | — | 13·6 | 14·5 | 0·2 | 34·1 | 36·7 | 0·2 |
| 4 | 47·0 | 39·1 | 0·001 | 8·4 | 6·7 | 0·01 | 14·3 | 10·2 | 0·0 |
| 16 | 24·7 | 16·6 | 0·001 | 4·0 | 3·6 | — | 3·4 | 2·7 | — |

* Values greater than 0·2 not listed

All the parameters derived from the stress–strain curve show, like the alkali-insolubility values, that the low-crimp wool has suffered greater degradation as a result of acid treatment. The properties derived from the yield portion of the curve (stress at 20 per cent extension, energy for 20 per cent extension) exhibit less change after acid attack, and differentiate less clearly between the two wools than either the low-strain properties (uncrimping stress, elastic modulus, stress at 5 per cent extension) or the properties at break (particularly breaking stress and breaking energy).

The difference between the two wools in their susceptibility to chemical degradation is sufficiently large to be detectable in the properties of fibres from fabric dyed with metallized acid dyestuffs; furthermore, this difference is reflected in the resistance of the fabric to flex-abrasion, wet, determined on the Stoll tester[4].

Preliminary results on other wools do not suggest that the difference in response to acid attack between the two specimens studied is related directly to their crimp configuration.

This work forms part of the Wool Research Project of the Textile Research Institute, supported by the International Wool Secretariat and a group of industrial sponsors.

J. Menkart
Jeanne Detenbeck

Textile Research Institute,
Princeton, New Jersey.
March 26.

[1] Dusenbury, J. H., and Jeffries, E. B., *J. Soc. Cosmetic Chem.*, **6**, 355 (1955).
[2] Dusenbury, J. H., Mercer, E. H., and Wakelin, J. H., *Text. Res. J.*, **24**, 890 (1954).
[3] Evans, F. T., and Montgomery, D. J., *Text. Res. J.*, **23**, 689 (1953).
[4] Stoll, R. G., *Text. Res. J.*, **19**, 394 (1949).

## Measurement of Mean Red-Cell Thickness by the Use of a Probability Function

When attempting to find the mean thickness of any kind of circular and biconcave red cell, one has either to be content with the mean corpuscular thickness, obtained by treating the cell as a cylinder and dividing the mean cell volume by $\pi r^2$, or one has to measure the dimensions of red cells on edge[1], thus obtaining the greatest thickness, the least thickness, and so on. The former method does not take the shape of the cell into consideration, and the latter method is laborious. This communication describes a new method, intermediate in accuracy but sufficiently reliable for many purposes. It depends on the fact that the number of red cells seen on edge, in a preparation in which the cells are randomly oriented, depends on the mean dimensions of the cells, including the diameter. Virtually no cell will be seen exactly on edge; but a number will present themselves in the direction of observation in such a way that their observed thickness will be less than a selected value $w$—where $w$ is a little larger than $t$, the true mean thickness. The probability $f$ of such cells being seen in the preparation is

$$f = \frac{w - t}{d - t} \qquad (1)$$

an expression for which we are indebted to Dr. R. T. Cox (the proof of this expression is a little too long to be included here; but we shall be glad to communicate it to anyone who is interested), and which treats the cross-section of the red cell as a rectangle with a semicircle at each end.

A preparation of red cells in plasma is made between slide and coverslip, and is examined under conditions of reasonable high resolution (× 20 objective, N.A. 0·5, × 5 eyepiece, and Köhler illumination). The preparation is stirred up by pressing on the coverslip so that the red cells move in the currents thus produced, and several fields are photographed (Leica 111 $f$ camera with Adox *KB*-17 film) at an exposure of 0·001 sec., provided by a Strobonar IV electronic flash. After development, the fields are projected at a magnification of about × 800, and a cell is considered to be on edge if its image falls within two lines separated by a distance $w$ and drawn on a glass plate; it is convenient to choose two values for $w$, one about 1·5 times and the other about twice the estimated cell thickness. The values chosen for $w$ are not particularly important, although they must be known exactly in $\mu$. The number of red cells on edge and the total number of cells in the fields examined give $f$, from which $t$, the mean cell thickness, can be calculated for each of the two values of $w$. Virtually the same value of $t$ is usually obtained from the two values of $w$.

This method has given excellent results. For the red cells of man $t = 2{\cdot}07 \pm 0{\cdot}1\mu$, which is in good agreement with the value found by photography of human red cells on edge[1]. For rabbit red cells, $t = 2{\cdot}1 \pm 0{\cdot}1\mu$, which again agrees with direct observations if one allows for the limitations which the latter suffer because of diffraction phenomena at the cell edge. For the mouse red cell, $t = 2{\cdot}05 \pm 0{\cdot}05\mu$.

A corollary to expression (1) is that if no red cell or ghost presents itself on edge, the cells or ghosts are necessarily spherical. Their volume is then $4\pi r^3/3$, where $r$ is their radius, and their surface area is $4\pi r^2$.

Eric Ponder
Delia Barreto

Nassau Hospital,
Mineola, New York. April 4.

[1] Ponder, E., *Quart. J. Exp. Physiol.*, **20**, 29 (1930).

## Electrical Properties of the Plasma Membrane of Erythrocytes at Low Frequencies

Earlier investigations of the dielectric properties of biological interfaces dealt with the plasma membrane of erythrocytes and obtained from its capacitance a value of its thickness near $10\varepsilon_M$A., where $\varepsilon_M$ is dielectric constant of membrane[1]. Other contributions considered the possibility of a frequency dependence of cellular membrane impedance which can be expressed by a power law[2]. Both frequency dependence of membrane and complexity arising from variability in cell size and shape may affect similarly dielectric properties of cellular suspensions in the $R_F$-range.

Thus, measurements of biological interfaces at lower frequencies than previously investigated are indicated to differentiate power law behaviour of interface from form and size variation effects.

This study was undertaken to obtain data of resistivity and capacitance of erythrocytes at low frequencies. Accurate impedance measurements on red cell suspensions were obtained in a frequency-range of 10–200,000 c./s. Heparinized fresh beef blood was washed with Ringer tyrode, $p$H 7·6, and centrifuged to 80–90 per cent volume concentration of erythrocytes. The packing was done to reduce artefacts due to electrode polarization[3]. This concentrated suspension was placed in a cylindrical electrolytic cell, the impedance of which was measured in a precision bridge[4]. Temperature was stabilized to 25° C. ± 0·01° C. Effects of distributed capacitances and leakage conductances were eliminated by a substitution technique. The measurements of impedance as function of frequency ($f$) were made with high accuracy, resistance to ± 0·0005 per cent except at 10 c./s. and capacity to $(0{\cdot}5/f_{\text{kc.}} \pm 0{\cdot}5)$ per cent. Changes due to small temperature variations and sedimentation were eliminated by alternating experimental measurements with control readings at 1 kc./s. The small drift of the control readings with time was found independent of frequency and used for determining corrections for the experimental data at other frequencies.

Electrode polarization impedance, which appears in series with the sample impedance, was nearly independent of sample volume. Hence, the difference between measurements at two electrode spacings could be taken to be proportional to the impedance of the differential blood volume[3,5]. Accuracy of these difference measurements was kept high by minimizing

Table 1

| kc./s. | $\frac{\varepsilon}{\varepsilon(1\text{ kc./s.})}$ | kc./s. | $\frac{\varepsilon}{\varepsilon(1\text{ kc./s.})}$ |
|---|---|---|---|
| 0·05 | 1·0 | 5 | 0·991 |
| 0·1 | 1·0 | 10 | 0·987 |
| 0·2 | 1·00 | 20 | 0·983 |
| 0·5 | 1·00 | 50 | 0·978 |
| 1 | 1·00 | 100 | 0·973 |
| 2 | 0·996 | 200 | 0·961 |

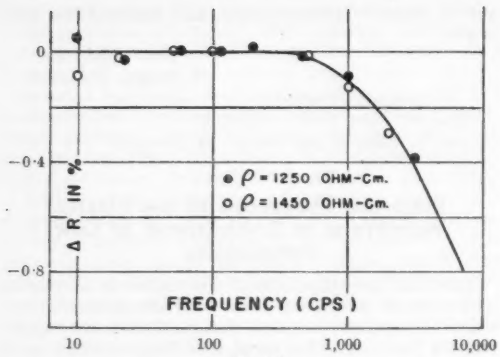



Fig. 1

polarization with electrodes heavily covered with platinum black and using large electrode spacing (up to 15 cm.). Fig. 1 represents specific resistance ρ of two samples. Results are typical of all samples investigated. Table 1 gives dielectric constant values, averaging eight samples. The drop in resistance above 1 kc./s. and in dielectric constant above 10 kc./s. is the result of the known dispersion caused by the cell interior. Measurements have also been carried out with rabbit blood with the same results. The frequency dependence reported previously by others for rabbit erythrocytes[5] between 500 and 5,000 c./s. cannot be confirmed.

The results in both resistance and capacitance support the frequency independent nature of the erythrocyte membrane. If a power law $C = C'f^{-m}$ would characterize membrane capacitance, then accuracy of capacitance data corresponds to $m$ deviating from zero by less than 0·004, that is, the phase-angle of the interface must be equal to 90° within 0·4°. From the frequency independence of resistance, and from measured capacitance of suspensions and known capacitance of plasma membrane[1], it follows that the conductance of the plasma membrane per cm.² of its surface is constant between 20 and 500 c./s. within 0·1m.mho. Electrical relaxation effects due to structure occur if different molecular layers are arranged in series[6]. Presuming such a structure, our results mean that dielectric losses of these layers are extremely small, placing the relaxation effect outside our range of observation. A more likely possibility to explain our results is a mosaic structure of the lipid–protein complexes[7]. Such a mosaic arrangement cannot show a frequency dependence, at least as long as its components are independent of frequency.

This investigation was supported by a research grant *H*-1253(*C*2) from the National Institutes of Health, Public Health Service.

T. P. Bothwell
H. P. Schwan

Electromedical Laboratory,
Moore School of Electrical Engineering
and Medical Schools,
University of Philadelphia. April 2.

[1] Fricke, H., *Nature*, **172**, 731 (1953).
[2] Fricke, H., Cold Spring Harbor Symposium Quant. Biol., **1** (1933).
[3] Schwan, H. P., *Z. Naturforsch.*, **6b**, 121 (1951).
[4] Schwan, H. P., and Sittel, K., *Trans. Amer. Inst. Elect. Eng.* (Comm. and Elect.), 114 (May 1953).
[5] Fricke, H., and Curtis, H. J., *J. Gen. Physiol.*, **18**, 821 (1935).
[6] Harvey, E. N., and Danielli, J. F., *Biol. Rev.*, **13**, 319 (1938).
[7] Parpart, A. K., and Ballantine, R., in "Modern Trends in Physiol. and Biochem." (Acad. Press, New York, 1952).

## Energy Relations of Mitotic Activity in Mouse Hair Bulbs

It is now recognized, especially from studies on the physiology of adult epidermis, that the energy requirements of mitotic activity are high[1]. There is a marked diurnal rhythm in epidermal mitotic activity, and this appears to be determined by variations in the rate of uptake of glucose from the blood. Hair bulbs contain cells which are epidermal derivatives; but their mitotic activity follows a remarkably individual pattern, which is not influenced by the diurnal rhythm. Waves of hair-growth pass slowly across the body of a mouse, and, according to the position of these waves, the hair bulbs are either completely quiescent or are engaged in the most violent mitotic activity.

It has been shown *in vitro* that epidermal mitotic activity is dependent on an adequate supply of glucose and oxygen so that, in the absence of one or other of these substances, mitosis is severely depressed or even eliminated. Efficient energy-production through respiration is essential to epidermal mitotic activity, and such activity cannot be supported by anaerobic means, although in embryonic tissues this is evidently possible[2]. The question now arises whether the peculiarly violent and short-lived mitotic activity of the hair bulbs in the growth zone is also dependent on respiration, or whether it is supported by some alternative or ancillary mechanism. The following experiments were designed to provide an answer.

Adult male mice of Kreyberg's *WLL* strain had their body hair removed by electric clippers, and within a few days the regions of active hair growth became obvious. When the leading edge of the advancing growth-wave had reached the flank regions, the mice were killed and a strip of skin containing active hair bulbs was removed from both sides of the body and cut into small pieces (size approximately 50 mm. × 100 mm.). The skin fragments, arranged so that each group consisted of three pieces of skin each taken from a different animal, were immersed in a phosphate-buffered saline medium maintained at 38° C. in a Warburg flask. They were incubated for 1 hr. in order to eliminate those mitoses which were present in the hair bulbs when the skin was taken from the mouse. Colchicine was then added and the incubation continued for a further 4 hr. During this period, all the developing mitoses were arrested in the metaphase by the colchicine. Full details of this technique have been given elsewhere[3].

In addition to determining the effects of the presence or absence of glucose and oxygen, a study was also made of the effects of cyanide (which inhibits the cytochrome system), of fluoride (which inhibits glucolysis) and of 2 : 4-dinitrophenol (which is said to inhibit energy transfer). The results, taken from sections cut 7μ thick, are given in Table 1.

Accurate mitosis counts, similar to those previously obtained for epidermis, were difficult to make; but it was found that the results were so uniform and so obvious that this was unimportant. There was high mitotic activity in the group given both glucose and oxygen, low mitotic activity in the group deprived of glucose, and no mitotic activity at all in the groups treated with nitrogen and with optimum concentrations of cyanide, fluoride and 2 : 4-dinitrophenol.

It is evident from these results that the energy relations of mitosis in hair bulbs are similar to those

Table 1. Mitotic Activity in Mouse Hair Bulbs incubated *in vitro* for 4 hr. at 38° C.

| Phosphate-buffered saline | Gas phase | Inhibitors | Mitotic activity |
|---|---|---|---|
| + 0·02 *M* Glucose | Oxygen | None | ++ |
| Saline alone | Oxygen | None | + |
| + 0·02 *M* Glucose | Nitrogen | None | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·0005 *M* Cyanide | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·001 *M* Cyanide | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·005 *M* Cyanide | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·0005 *M* Fluoride | + |
| + 0·02 *M* Glucose | Oxygen | 0·001 *M* Fluoride | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·005 *M* Fluoride | 0 |
| + 0·02 *M* Glucose | Oxygen | 0·0001 *M* Dinitrophenol | 0 |

Note: ++ indicates high mitotic activity.
+ indicates low mitotic activity.
0 indicates full inhibition of mitotic activity.

already described for epidermis. In the first place, it appears that sufficient energy is stored during the antephase to ensure that, when glucolysis and respiration are inhibited, any mitoses already in progress are capable of passing to completion. In the second place, it is clear that few, if any, new mitoses can develop in cells in which the antephase storage of energy is prevented by the absence of glucose or oxygen. Normally, in the rapidly dividing cells of the hair bulbs this storage of energy must occur very quickly. It evidently depends on active respiration, and it cannot be accomplished by glucolysis alone.

It has been suggested that the normal ability of an epidermal cell to undergo mitosis is limited by the degree of activity of the cell surface in absorbing glucose. If the same is true in the case of mouse hair bulbs, then it appears that, according to the stage of the hair cycle, these cells must alternate between an exceedingly low and an exceedingly high rate of glucose uptake, or, in other words, between a state of very low and very high cell-surface activity.

We thank Miss Anne Rogers for her assistance in this investigation, which was supported by a grant from the British Empire Cancer Campaign.

W. S. Bullough
Edna B. Laurence

Department of Zoology,
Birkbeck College,
University of London. Feb. 21.

[1] Bullough, W. S., *Biol. Rev.*, **27**, 133 (1952).
[2] Pomerat, C. M., and Willmer, E. N., *J. Exp. Biol.*, **16**, 232 (1939).
[3] Bullough, W. S., *Exp. Cell Res.*, **7**, 176 (1954).
[4] Bullough, W. S., *Vitamins and Hormones*, **13**, 261 (1955).

## Assay of Spider Venom and Antivenene in *Drosophila*

During studies on the toxicity of the venom of the Australian red back spider (*L. hasseltii*) it was found that the venom injected into *Drosophila* causes paralysis of the insect. This effect has been utilized for assaying antivenene.

Venom was obtained from the dissected venom glands of *L. hasseltii* as described elsewhere[1]. About 0·2 c.mm. of varying concentrations of venom was injected with a capillary pipette into the thorax of *Drosophila* under carbon dioxide anæsthesia. The results are shown in Table 1, where the amount of venom which was injected is expressed in fractions of the venom of one spider. With the higher concentrations of venom, the insects became paralysed within 5–20 min. after the injection. With concentrations of venom near the minimum lethal dose the insects showed progressive difficulty in turning over when they were made to fall on their backs and became paralysed without recovery during the next 24 hr. Results were recorded 24 hr. after the injections. It can be seen from Table 1 that $5 \times 10^{-6}$ of the amount of venom contained in one spider constituted the minimum lethal dose for *Drosophila*. It has been found previously that on the average one spider contains about 0·1 mgm. of venom. Thus $5 \times 10^{-7}$ mgm. of spider venom was sufficient to kill one *Drosophila* weighing about 1 mgm. A mouse of 20 gm. is usually killed by 0·2 of the amount of venom of one spider. On the basis of body-weight the venom of *L. hasseltii* is therefore approximately eight times more toxic in *Drosophila* than in the mouse. Millot[2] suggested that spider venom is most toxic to those animals on which the spider normally feeds.

Table 1. Toxicity of Spider Venom in *Drosophila*

| Amount of venom : in fractions of one spider ($\times 10^{-2}$) | No. of insects | No. paralysed |
|---|---|---|
| 0·2 | 6 | 6 |
| 0·1 | 3 | 3 |
| 0·05 | 3 | 3 |
| 0·02 | 3 | 3 |
| 0·01 | 3 | 3 |
| 0·005 | 3 | 3 |
| 0·002 | 3 | 0 |
| 0·001 | 3 | 0 |
| 0·0005 | 3 | 0 |

Antivenene was prepared in a rabbit using venom adsorbed on aluminium phosphate[1]. The antivenene (*F*7) used here was obtained seven days after the second dose of venom. Using mice, it was found that one millilitre of serum neutralized the venom of four spiders.

For assaying antivenene in *Drosophila*, equal volumes of fixed quantities of venom were mixed with varying dilutions of serum. Each dose of 0·2 c.mm. contained the venom of 0·0001 spider which corresponded to twenty lethal doses. Table 2 shows the amounts of serum injected with each dose and the results which were obtained. It can be seen that $0{\cdot}3 \times 10^{-4}$ ml. of serum neutralized $1 \times 10^{-4}$ of the amount of venom contained in one spider. One millilitre of serum, therefore, neutralizes the venom of about 3·3 spiders. This result agreed reasonably well with that obtained when the same serum was assayed in mice.

The use of *Drosophila* as an index of antigen–antibody reaction for the titration of spider antivenene enables a larger number of lethal doses of venom to be injected and neutralized than is practicable in the case of mice. A more reliable estimate of the potency of the serum is therefore possible[3]. At the same time, there is a considerable saving in the amount of venom required for assaying antivenene, and results are available within 24 hr.

The method here described is simple and might prove useful for assaying antisera of medical import-

Table 2. Assay of Spider Antivenene in *Drosophila*

| Amount of venom : in fractions of one spider ($\times 10^{-2}$) | Amount of serum ($F_7$) in millilitres ($\times 10^{-4}$) | No. of insects | No. paralysed |
|---|---|---|---|
| 0·1 | 0·01 | 5 | 5 |
| 0·1 | 0·012 | 5 | 5 |
| 0·1 | 0·02 | 5 | 5 |
| 0·1 | 0·025 | 5 | 3 |
| 0·1 | 0·03 | 4 | 0 |
| 0·1 | 0·05 | 4 | 0 |
| 0·1 | 0·1 | 4 | 0 |
| — | 0·1 | 4 | 0 |

ance prepared against other venoms and toxins which also happen to be toxic to insects.

S. Wiener
Commonwealth Serum Laboratories,
Melbourne.

F. H. Drummond
Department of Zoology,
University of Melbourne.
March 9.

[1] Wiener, S., *Med. J. Aust.*, [1, 739 (1956)].
[2] Millot, J., "Traité de Zoologie" (Paris, 1948).
[3] Schöttler, W. H. A., *Bull. World Health Organ.*, **12**, 877 (1955).

## Histamine and Histidine in Excreta of the Blood-sucking Bug *Rhodnius prolixus*

Paper chromatographic studies of the dry excreta of *Rhodnius* fed in the laboratory on the rabbit have shown the presence of the following amino-acids or related compounds: leucine, histidine, histamine, taurine, glycine, valine, phenylalanine and alanine—the first three giving particularly intense spots with ninhydrin.

The presence of histidine and its amine in substantial concentration was confirmed by tests with the diazo reagent of Pauly as applied to chromatograms by Dent[1]. Histidine was further checked by parallel runs with pure substance. The histamine spot corresponds to the position allotted to it in the literature[1] and when eluted with 0·9 per cent sodium chloride solution, and scratched into the skin, it gave a marked reaction compared to a negative response with distilled water. A value of 0·041 mgm. histamine/100 mgm. dry excreta was obtained by an assay kindly performed by Dr. W. E. Ormerod on guinea-pig ileum by comparing the contractions produced with those produced by a standard dose of known histamine concentration.

A semi-quantitative study of the free amino-acids in *Rhodnius* hæmolymph by the method of Auclair and Dubreuil[2] has shown that histidine accounts for almost 35 per cent of the total free amino-acids detected (2,594 μgm./ml.). It is well in excess of all others in the amino-acid picture. It was not detected in excreta of bugs fed on horse serum through a rubber membrane, and histamine was present in low concentration. Sterile bugs, that is, bugs deprived of their intestinal micro-symbionts, *Actinomyces rhodnii*, gave excreta with a significant decrease of histidine but with an intense histamine spot.

The high concentration of histidine in both hæmolymph and excreta of *Rhodnius* is similar to that found in *Bombyx mori*, where it has been detected in hæmolymph of larvæ[3] in equally high concentration[7], of pupæ[4] and of adults[5]. In addition, it has been found in large amount in larval fæces[6] and adult urine[5]. There appear to be no previous records of the detection of histamine in insect excreta or tissues.

Histamine was not detected in *Rhodnius* hæmolymph at any time, so one can assume that decarboxylation of histidine has occurred in the gut prior to elimination of the amine. Since it appears in excreta of sterile insects, it must arise as a result of tissue decarboxylation of histidine and not by bacterial agency. Also, the absence of histidine (and most of the amine) in excreta of serum-fed bugs suggests that both may be derived predominantly from the substantial concentration of histidine in the dietary blood, where it forms 6–10 per cent of the globin derived from hæmoglobin[8]. In other words, the red blood cells in the diet account for the high concentration of histidine and its amine in the excreta. There is further confirmation for this, as histamine does not appear in the copious urine immediately after the blood meal but only in the excretory products of digestion which takes place weeks after ingestion of the blood. Ingested hæmoglobin may remain red for several weeks[9]. The lower concentration of histidine in excreta of sterile insects is difficult to explain as it does not correspond to any change in its amine, which is present in high concentration. It is possible that the intestinal symbionts are contributing histidine to the host.

The detection of histamine, a 'tissue poison', in high concentration in the gut is particularly interesting. It is curious to find an organism converting a harmless substance into a 'toxic' derivative before excreting it. The presence of both these substances could be further elucidated by studies on the excreta of other blood-sucking insects.

This research formed part of a study for the degree of Ph.D. of the University of London and was carried out under the late Prof. P. A. Buxton, whose fundamental criticisms and assistance were most valuable. It is a pleasure to thank the South African Council for Scientific and Industrial Research for generous financial support during the study.

J. S. Harington*
Department of Entomology,
London School of Hygiene and Tropical Medicine,
London.
April 27.

* Present address: National Chemical Research Laboratory, South African Council for Scientific and Industrial Research, Pretoria.

[1] Dent, C. E., *Biochem. J.*, **43**, 169 (1948).
[2] Auclair, J. L., and Dubreuil, R., *Canad. J. Zool.*, **30**, 109 (1952).
[3] Fukuda, T., *J. Seric. Sci. Tokyo*, **19**, 372 (1950). Yoshitake, N., and Aruga, H., *J. Seric. Sci. Tokyo*, **19**, 534 (1950).
[4] Fukuda, T., and Sakano, S., *J. Seric. Sci. Tokyo*, **19**, 490 (1950).
[5] Yoshitake, N., and Aruga, H., *J. Seric. Sci. Tokyo*, **19**, 538 (1950).
[6] Yoshitake, N., and Aruga, H., *J. Seric. Sci. Tokyo*, **19**, 536 (1950).
[7] Fukuda *et al.*, *Nature*, **175**, 1041 (1955).
[8] See Haurowitz, F., "Chemistry and Biology of Proteins", 207 (Academic Press Publishers, New York, 1950).
[9] Wigglesworth, V. B., *Parasitology*, **28**, 284 (1936).

## The Small Saphenous Vein as a Route for Intravenous Injection in the White Rat

A number of years ago, in searching for an accessible vessel from which blood could readily be obtained several times a week, we found that the small saphenous vein could easily be visualized and entered through the skin on the dorsum of the rat's foot. This vessel has since proved far more satisfactory than the commonly used tail vein for either bleeding or injection[1,2]. The technique of injection by this route has been briefly, but obscurely, described[2], and it thus remains not generally known.

The location of the small saphenous vein on the foot is shown in Fig. 1. The unanæsthetized rat is prepared for injection by wrapping in a towel or by insertion in a restraining cylinder. In either case, the one leg chosen for injection is left protruding. Shaving the area over the vein not only makes it easier to see through the skin, but also by provoking increased circulation causes the vein to distend prominently. The latter effect may be enhanced by washing the skin with 70 per cent alcohol and by snapping one's finger against the foot; application

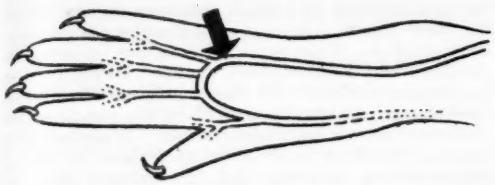


Fig. 1. Dorsal venous arch on the right hind foot of a rat. The small saphenous vein forms the lateral limb of the arch proximal to the arrow

of heat has never been necessary. The operator holds the foot by the toes during the procedure, and an assistant aids by holding the knee in such a manner that its sudden flexion and consequent withdrawal of the foot are prevented. A 1-in., 26-gauge hypodermic needle directed toward the ankle is inserted through the skin and into the vein at the approximate point indicated by the arrow in Fig. 1. With pressure of the operator's thumb over the point of insertion, the foot and needle are held firmly between thumb and index finger so that with any slight movement of the foot the needle and syringe move with it. Extreme variations from the venous pattern illustrated are rare and constitute no special hazard.

J. W. Everett

Duke University School of Medicine,
Department of Anatomy,
Durham, North Carolina.

C. H. Sawyer

School of Medicine,
Department of Anatomy,
University of California at Los Angeles.

[1] Sawyer, C. H., and Everett, J. W., *Endocrin.*, **39**, 307 (1946).
[2] Sawyer, C. H., Everett, J. W., and Markee, J. E., *Endocrin.*, **44**, 218 (1949).

## A pH Gradient Agar Plate

It is often advantageous for the microbiologist to know the *p*H limits within which a micro-organism will grow, and the influence of *p*H on the antimicrobial action of various drugs. Customarily, such studies are carried out in a series of separate vessels, each adjusted to a different *p*H-level. This note describes a modification of the Szybalski gradient plate technique[1] so as to provide a *p*H gradient across the surface of an agar plate, thus facilitating studies involving *p*H effects on the growth of micro-organisms.

The Szybalski technique involves solidification of a layer of agar (containing an antibiotic) while the Petri dish is held in an inclined position. An equal amount of agar is then added which is allowed to harden while the plate is level, thus forming two complementary slanted layers, and establishing a graded antibiotic concentration across the plate. The modification presented involves the introduction of $K_2HPO_4$ into the lower layer, and $KH_2PO_4$ into the upper layer (antibiotic omitted). In practice 1*M* buffer solutions are sterilized separately and added to the medium just prior to pouring (1 : 10 v/v). These plates develop a gradient ranging from about *p*H 5·6 to *p*H 7·8 and which is readily visualized by placing filter paper strips, each impregnated with a different *p*H indicator, on the agar surface. The colours formed provide a convenient guide to the *p*H at any position along the gradient. A photograph of such a plate with indicators transferred to the

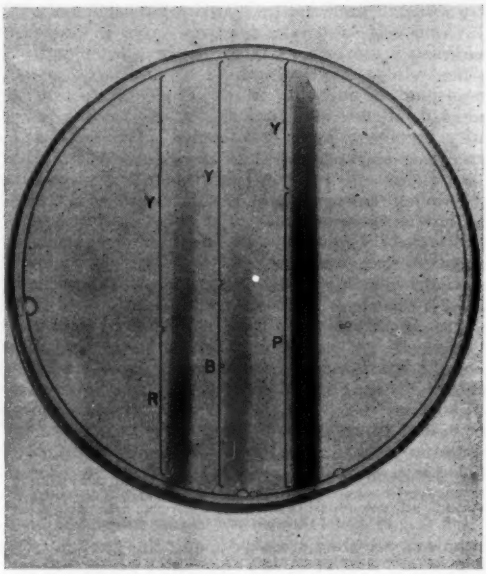



Fig. 1. *p*H gradient plate, showing *p*H indicators transferred to the agar by contacting the agar for about ten minutes with filter paper strips impregnated with the indicator. Indicators are (left to right) phenol red, brom thymol blue, brom cresol purple. Bottom is alkaline, top acidic

agar (after removal of the paper strips) is shown in Fig. 1.

The influence of *p*H upon antibiotic action can be determined in several ways. The simplest is to incorporate the antibiotic in a thin surface layer (10 ml. per 150 mm. plate) of 2 per cent agar. The test

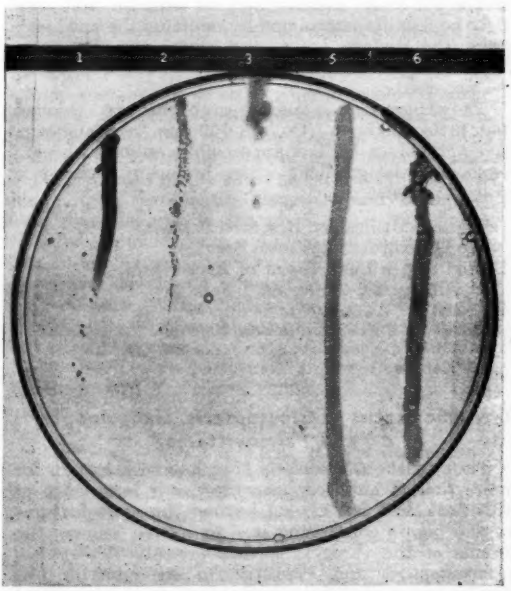



Fig. 2. Influence of *p*H on the antibacterial action of streptomycin. 1, *Staphylococcus aureus* (H). 2, *S. aureus* FDA 209. 3, *Bacillus megaterium* B-938. 5, *Escherichia coli* 456. 6, *Serratia marcesens*. Surface layer contains 20 p.p.m. Note absence of growth in alkaline regions for organisms 1, 2, 3

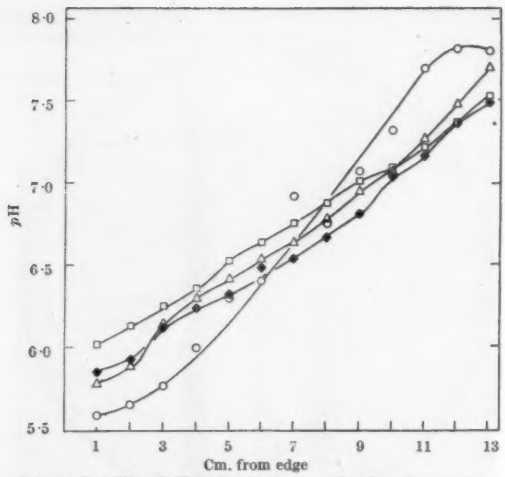



Fig. 3. Stability of *p*H gradient. ○——○, 1 hr. after pouring agar; △——△, 1 day; ■——■, 2 days; □——□, 8 days; *p*H determined with glass electrode; plates held at 25° C., 0 to 4 days; at 5° C., 4 to 8 days

organisms are then streaked along the gradient with swab sticks soaked in suspensions of 24-hr. cultures. Several plates, each with a different antibiotic concentration, are generally prepared, along with a control plate from which the antibiotic is omitted. Fig. 2 shows the increased effectiveness of streptomycin in the alkaline region[2]. An alternative method (cf. Streitfeld and Saslaw[3]) involves placing a filter-paper strip impregnated with the antibiotic on the plate and overlayering with a thin layer of 1 per cent agar containing the inoculum. Flaring of the inhibition zone indicates increased activity in that region of the gradient.

The *p*H limits within which an organism will grow may be readily determined by omitting the antibiotic from the surface layer, and streaking. By using $H_2PO_4$ instead of $K_2HPO_4$ a *p*H range of 2 to 5 may be obtained.

The *p*H gradient is quickly established, and changes but little in 48 hr. On the 150-mm. plates shown, the *p*H values shifted appreciably only at the extremes of the gradient where buffering capacity is poor (Fig. 3).

L. E. Sacks

Western Utilization Research Branch,
Agricultural Research Service,
United States Department of Agriculture,
Albany 10, California. Feb. 2.

[1] Szybalski, W., *Science*, **116**, 46 (1952).
[2] Wakeman, S. A., Proc. Staff Meeting, Mayo Clinic, **19**, 537 (1944).
[3] Streitfeld, M. M., and Saslaw, M. S., *J. Lab. and Clin. Med.*, **43**, 946 (1954).

## Generic Status of *Glossopteris*, *Gangamopteris* and *Palæovittaria*

Though the *Glossopteris* flora has been known for more than a hundred years now, our knowledge of this flora does not extend beyond the gross features of the plants comprising it. As is well known, the fronds of the three important genera, *Glossopteris*, *Gangamopteris* and *Palæovittaria* are more or less similar in external form and are usually distinguished by the presence or absence of midrib and anastomosing of the secondary veins. But many times the characters of one genus merge into another and then it becomes difficult to refer it definitely to any one of the three genera. Some good examples are, *Glossopteris mitchelli*, *Glossopteris intermittans*, *Glossopteris decipiens* and *Gangamopteris indica*. Owing to such inconsistency shown by these external characters, doubts were raised in the past about the generic status of *Gangamopteris* and *Palæovittaria*. It appears that between the three genera there are no sharply defined distinguishing features, and the criteria like the presence or absence of midrib and the anastomosing of secondary veins are too inconsistent to be relied upon as generic characters.

As Prof. B. Sahni[1] remarked, while describing the cuticle of *Glossopteris angustifolia*, in dealing with material of this nature any information that took us beyond the gross features would be welcome. Fortunately in India these plant remains are found as impressions, many of which are carbonized and therefore suitable for cuticular studies.

Such studies of the *Glossopteris* flora of India have now been taken up at this Institute. The late Dr. P. N. Srivastava made cuticular studies of the following:

*Glossopteris browniana*, *G.* cf. *divergens*, *G. communis*, *G. communis* var. *stenoneura*, *G. conspicua*, *G. formosa*, *G. retifera*, *G. damudica*, *G. intermittans*, *G. tæniopterioides*, *G. sahnii*, *G. arberi*, *G. longicaulis*, *G. tænioides*, *Gangamopteris* cf. *cyclopteroides*, *G.* cf *hughesi*, *G. indica*, *G. flexuosa*, *G.* sp. *A.*, *G.* sp. *B.* *Palæovittaria kurzi*.

He compared all his specimens with the type specimens which were available, and it is provisionally presumed that the specific determinations are correct.

Srivastava's cuticular studies show that it is again not possible to delimit the three genera as defined at present on the basis of epidermal characters, because there are species in two genera which show very similar characters and some species of a single genus show such diversity as cannot be regarded only of specific importance. It is therefore evident that the three genera include diverse types, perhaps belonging to different genera, but possessing somewhat similar external features.

If only epidermal characters are taken into consideration, the various species of the three genera described by Srivastava fall into six groups which may provisionally be considered as of generic rank. For example, *Glossopteris angustifolia* and *G. retifera* might well be the species of a single group, whereas *G. formosa* and *G. communis* appear to be the species of another group. Similarly, *Gangamopteris* cf. *cyclopteroides* and *G.* cf. *hughesi* are the species of two distinct groups. Srivastava's studies are shortly to be published in full in the *Palæobotanist*.

However, before the three genera are broken up into natural genera, one important fact has to be taken into consideration. Recently some fructifications have been described as borne on the leaves of certain *Glossopteris* species[2] and it can be hoped that similar discoveries may be made in the case of other related genera. When such organs are found in connexion it is natural to connect them together and define more exactly the taxonomic limits of the plant to which they belong. But before doing so in the case of *Glossopteris* and other related genera it would be desirable if the true identity of the leaves is first established on the basis of cuticular study (provided, of course, the cuticle is available). Otherwise, as Srivastava's studies have shown, the identification of a fructification-bearing leaf based only on external features may be wrong to start with and consequently

lead to wrong conclusions regarding the definition of the plant represented by these organs.

K. R. Surange

Birbal Sahni Institute of Palæobotany,
Lucknow.

[1] Sahni, B., *Rec. Geol. Surv. India*, **54**, 3 (1923).
[2] Plumstead, E. P., *Trans. Geol. Soc. South Africa*, **55** (1952).

## Polyploidy and Radiosensitivity

The effect of polyploidy on the radiosensitivity of cells has been the object of some discussion in the past, and it may be of some practical importance in such cases as cancer therapy, for example, since tumours are often mixed diploid–polyploid populations[1,2]. For chromosomal aberration production by radiation, polyploid sensitivity equal to[3,4], greater than[3], and less than[5,6] the diploid have been reported. Each of the various experiments involved a comparison of different diploid and polyploid species, and the lack of agreement between the experiments may be due to intrinsic differences in species sensitivity, rather than to the effect of polyploidy itself.

This conclusion probably is not compromised by differences in stage and sensitivity of the haploid and diploid cells, which could result from a possible difference in the rate of development of the cells. Both kinds of cells displayed only the chromosome type of aberrations, which indicates that both were in the same stage, interphase, when irradiated. In addition, radiosensitivity in this interphase is known to be uniform for not less than one day before and one day after the time the radiation was delivered[5].

The observation that for the same dose diploid cells have only twice as many exchange aberrations per cell as the haploid cells affords geometric evidence of the limitation of space over which chromosome breaks can interact to produce an exchange. It is known that with X-rays, exchange aberrations, which result from the interaction of two independently produced breaks, increase as the square of the dose; it is believed with considerable reason that the breaks increase linearly with dose[7]. Now, per nucleus, a doubling of the number of breaks can be achieved by doubling either the dose (chromosome number constant) or the chromosome number (dose constant). In terms of concentration, doubling dose doubles the number of breaks per nucleus, and also breaks per unit volume; however, doubling chromosome number doubles only breaks per nucleus—breaks per unit volume remain the same if volume is also doubled. The ratio of diploid to haploid volumes, both cellular and nuclear, on this slide was roughly about 2·8 : 1, as estimated from the ratio of measurements made on pairs of cells in the same stage and lying side by side; total chromosome length, from metaphase measurements, was in the ratio 2 : 1. The finding that, for the same dose, a diploid cell has twice, not four times, as many aberrations as a haploid cell shows that breaks do not exchange freely over the entire volume of the nucleus but only over a very limited volume. Two breaks, to exchange, must be very close together.

Table 1. Chromosome Aberration Production by 500 r. of X-Rays in Haploid and Diploid Microspores within a Single Flower Bud of *Tradescantia*

| Cell type | No. of cells | Aberrations per 100 cells | | | | | |
|---|---|---|---|---|---|---|---|
| | | Exchanges | | | Deletions | | |
| | | Intrachange, interarm (centric rings) | Interchange* (dicentrics, etc.) | Total ± S. E. | Interstitial 'minutes' | Terminal | Total ± S. E. |
| Haploid (6 chromosomes) | 50 | 22 | 160 | 182 ± 19 | 292 | 60 | 352 ± 26 |
| Diploid (12 chomosomes) | 25 | 16 | 344 | 360 ± 38 | 624 | 157 | 776 ± 56 |
| Ratio of diploid to haploid aberrations per cell | | | | 2·0 : 1 | | | 2·2 : 1 |
| aberrations per chromosome | | | | 0·99 : 1 | | | 1·1 : 1 |

* No. of interchanges = 1 (dicentrics) +2 (tricentrics) + 3 (quadricentrics) + . . .; for haploid cells = 1 (82) + 2 (24) +3 (10) + 4 (0) = 160; for diploid cells = 1 (240) + 2 (32) + 3 (8) + 4 (4) = 344.

The ideal situation—irradiation within a single tissue or organ of a single mixed population of normal cells and polyploid cells derived from them—was realized through a fortunate accident in a *Tradescantia* radiation experiment designed for another purpose. A single *Tradescantia paludosa* flower bud (made into a single acetocarmine slide) was found with a mixed population of haploid and diploid microspores. The bud had been irradiated four days previously (500 r. of 250-kVp. X-rays in 1 min., hvl., 1·45 mm. of copper) while the cells were in postmeiotic interphase, an extended period of uniform radiosensitivity; the bud was examined at the microspore mitotic division. About half (48 per cent) of the cells were diploids.

Chromosome aberrations were carefully counted at metaphase in 50 of the haploid (6-chromosome) and 25 of the diploid (12-chromosome) microspores, with the results given in Table 1.

The aberrations observed in both haploid and diploid cells are the customary chromosome kinds resulting from irradiation of undivided chromosomes in interphase. Per cell, the diploid cells have almost exactly twice as many aberrations as the haploid. However, *per chromosome* (since there are twice as many chromosomes per cell in the diploid) the aberration frequency is the same in the diploid and haploid cells. Thus, in the ideal situation of mixed cells in the same tissue, we can say that chromosomal radiosensitivity, or sensitivity per unit length of chromosome, is identical in haploid and diploid cells.

This work was performed under Contract No. W-7405-eng-26 for the U.S. Atomic Energy Commission.

Alan D. Conger
A. Helen Johnston

Biology Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee. June 1.

[1] Hauschka, T. S., Kvedar, B. J., Grinnel, S. T., and Amos, D. B., *Ann. New York Acad. Sci.*, **63**, 683 (1956).
[2] Levan, A., *Ann. New York Acad. Sci.*, **63**, 774 (1956).
[3] Bishop, C. J., *Canad. J. Bot.*, **30**, 139 (1952).
[4] Smith, L., *J. Agric. Res.*, **73**, 137 (1946).
[5] Sax, K., and Swanson, C. P., *Amer. J. Bot.*, **28**, 52 (1941).
[6] Fröier, K., Gustafsson, Å., and Tedin, O., *Hereditas*, **28**, 165 (1942).
[7] Lea, D. E., "Actions of Radiations on Living Cells" (Cambridge Univ. Press, 1947).

## *Allium neapolitanum*: a Mixed Species

In two samples of *Allium neapolitanum* bulbs, received from Van Tubergen, Holland, Levan[1] reported 14 and 28 chromosomes. Feinbrun[2] also reported the tetraploid form ($2n = 28$) of this species growing wild in Palestine. In a sample I have received from de Jager's, Holland, I have found only the diploid. In a second sample, however, there were again tetraploids; in addition there were two new types, triploids ($2n = 21$) and pentaploids ($2n = 35$).

No great differences were observed in chromosome form between the four strains. All of them had chromosomes, ranging in size from 8$\mu$ to 12$\mu$, with median or submedian centromeres. However, an interesting feature was observed in one small chromosome of the triploid and occasionally of the tetraploid form. There was a pronounced attenuation of the centromere, which had the appearance of a long thread joining the two arms. An analogous situation has been described in several species. It has been attributed to two possibilities: (1) to unspiralized heterochromatin at one side of the centromere, as in *Fritillaria lusitanica*[3] and *Fritillaria pyrenaica*[4]; (2) to a close proximity of the nucleolar organizer, which seems to be the case in *Poa alpina*[5] and in *Campanula persicifolia*[6]. There are also other examples where for reasons unknown the centric constrictions appear accentuated, as in *Aconitum*[7] and in *Crocus*[8].

The presence of an extended polyploid series in *Allium neapolitanum* reminds one of the situation described by Levan[9] in *Allium nutans*, where the whole range from $2x$ to $12x$ was found. The fact that three different forms can occur in the same commercial sample of bulbs seems, however, unprecedented. It suggests that this species has a form of versatile reproduction in which either fertilization or meiosis, or both, may be omitted from the normal sexual process.

This investigation was made possible by a scholarship from the State Scholarships Foundation of Greece, to which grateful acknowledgment is made.

Maria Kefallinou Hattersley-Smith

Botany Department,
Oxford.
March 26.

[1] Levan, A., *Hereditas*, **20**, 289 (1935).
[2] Feinbrun, N., *Palest. J. Bot., Jerusalem*, **5**, 13 (1950).
[3] Botelho, M., and Mendes, E. J., *Portug. Acta Biol.*, **1**, 310 (1946).
[4] La Cour, L. F., *Heredity*, **5**, 37 (1951).
[5] Müntzing, A., *Heredity*, **2**, 49 (1948).
[6] Darlington, C. D., and La Cour, L. F., *Heredity*, **4**, 217 (1950).
[7] Darlington, C. D., "Recent Advances in Cytology", 37 (1937).
[8] Mather, K., *J. Genet.*, **26**, 129 (1932).
[9] Levan, A., *Hereditas*, **22**, 278 (1936).

## A Gene for Eyelids Open at Birth in the House Mouse

In a stock of mice kept by one of us (J. H. B.) there has arisen a mutant gene which in the homozygous condition causes the eyelids to be open at birth. A similar character has been observed in mice by others[1,2]; but this seems to be the first occasion on which it has been found to have a simple genetical basis.

In a normal mouse the eyelids fuse about five days before birth and reopen about nineteen days later.

Table 1. Data from Backcrosses in Coupling for *wa*-1 and *co*

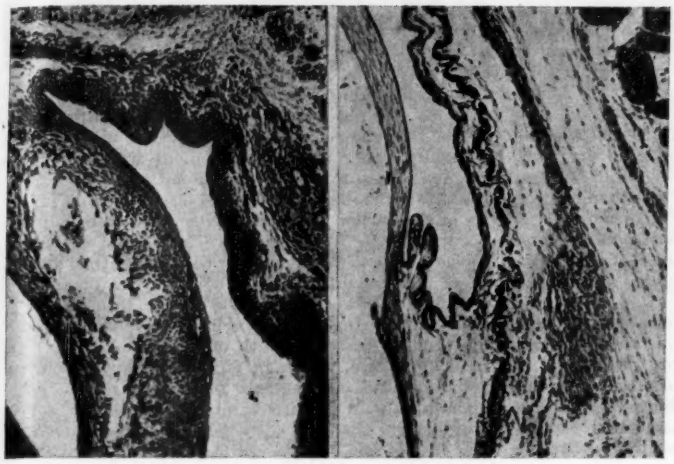
| Sex of heterozygous parent | Offspring | | | | |
|---|---|---|---|---|---|
| | *wa*-1 *co* | *Wa*-1 *Co* | *wa*-1 *Co* | *Wa*-1 *co* | Total |
| Female | 39, 40 | 49, 48 | 4, 1 | 1, 4 | 93, 93 |
| Male | 54, 47 | 43, 43 | 6, 7 | 4, 2 | 107, 99 |

The first figures refer to females, the second to males

In the abnormal mice described here, there is no pre-natal fusion of the eyelids. One day after birth an inflammatory exudate covers the eye opening; about four days later this falls away and a whitish excrescence may be seen in the superior fornix conjunctivæ. This excrescence gradually decreases in size and has usually disappeared by the eighteenth day after birth. The eye is then smaller than normal. Corneal opacity results but tends to diminish with advancing age.

The recessive gene wavy-1 (*wa*-1) for wavy coat and vibrissæ was segregating in this stock, and at first the eye abnormality was observed only in *wa*-1 homozygotes. All offspring from matings between *wa*-1 homozygotes with abnormal eyes but none of the offspring from outcrosses of such abnormal *wa*-1 homozygotes had the eye abnormality. Some progeny from these outcrosses were mated together and others were backcrossed to the wavy parent with abnormal eyes. A few wavy mice with normal eyes and some non-wavy mice with abnormal eyes appeared in the next generation. The backcross data (Table 1) which have accumulated from this and later genera-

Fig. 1. Section through epithelium overlying the cornea, (*a*) in a four-day old mouse with eyes open at birth, showing œdema and polymorphonuclear infiltration of the substantia propria cornea with hyperplasia of the external epithelium, and (*b*) in a normal four-day old mouse. (× *c.* 387)



(a) (b)

Fig. 2. Section through the cornea, (*a*) in a four-day old mouse with eyes open at birth, showing swelling and vesiculation of substantia propria cornea, and (*b*) in a normal four-day old mouse. (× *c.* 83)

tions seem to indicate that 'eyelids open at birth' is due to a single recessive gene (*eo*) linked with *wa*-1, the recombination frequency being 5·376 ± 1·654 per cent in females and 9·223 ± 2·016 per cent in males. All these data have come from coupling backcrosses. Repulsion backcrosses, which have been set up, have not yet had time to produce offspring. Our estimates of the recombination frequency consequently may be biased because of differential viability. There was no noticeable difference in viability between the normal and affected mice under laboratory conditions; but the mutant homozygote presumably would be at a selective disadvantage in the wild.

More than three hundred mice with eyelids open at birth have now been reared and in all but ten (four females and six males) both eyes were affected. One of these ten mice had an abnormal right eye and the others had abnormal left eyes. In five other mice, the eyelids were open at birth but the conditions described above failed to develop.

Eyes of seventeen- or eighteen-day old embryos from an abnormal-eyed female crossed with a male heterozygous for the eye character were examined histologically. The thirteen embryos were sorted into two groups—those with opaque and those with clear eyes. Coronal sections of their eyes confirmed that the eyelids were open in embryos of the second, but not in those of the first, group. Six abnormal four-day old mice were also examined. The separated eyelids were swollen and purplish-red, and the cornea was visible. The eyes and lids of these mice and of six normal ones were excised and serially sectioned. The corneæ of the affected mice were thickened, the nuclei of the substantia propria were enlarged, and there was an infiltrate of a few polymorphonuclear leucocytes. The overlying epithelium, instead of being a single layer of cuboidal cells (Fig. 1), consisted of three or four layers with a few mitotic figures. The connective tissues of the eyelids were œdematous; but cellular infiltration was not conspicuous (Fig. 2). There was no indication of a conjunctival slough such as has sometimes been said to be associated with this condition[1].

The histological appearances suggest that infection may account for the abnormal post-natal eye conditions. The eyes and lids of several abnormal four-day old mice were therefore excised under sterile conditions, ground, and an extract prepared with a suspension of a sterilized rabbit serum in saline solution. This extract was centrifuged and the supernatant liquid, after it had been mixed with sufficient penicillin and streptomycin to destroy bacteria, was inoculated intraperitoneally into one group of three-day old mice and intracerebrally into another. None of these mice showed signs of disease during the ten days in which they were afterwards observed. The extract was also injected into eleven-day old chick embryos, by the chorioallantoic route in one group, and into the yolk sac in the other, but no growth of virus was detected. Cultures were prepared aerobically and anaerobically from the centrifuged material before the addition of penicillin and streptomycin; but no bacteria were detected.

Sections from the eyes of abnormal ten-day old mice showed œdema of the cornea, especially in its outer part. Polymorphonuclear leucocytes were scanty; and the overlying epithelium had fewer mitotic figures than did that from four-day old mice. In abnormal adult mice the cornea was found to consist of two distinct zones, an outer œdematous zone and an inner compact zone of fibrous tissue.

The histology indicates a mild inflammatory reaction with the subsequent development of corneal fibrosis leading to opacity. The hypothesis that the inflammatory reaction is due to trauma, probably associated with the eyes being open at birth, is supported by the presence of sterile cultures and by the absence of an inflammatory reaction in the corneæ of open-eyed mice *in utero*.

J. H. Bennett*

Department of Genetics,

G. A. Gresham

Department of Pathology,
University of Cambridge.
June 18.

* Present address: Department of Genetics, University of Adelaide.

[1] Gruneberg, H., "The Genetics of the Mouse" (Martinus Nijhoff, The Hague, 1952).
[2] Strong, L. C., Proc. Sixth Internat. Congr. Genetics, 2, 195 (1932).

## An Adhesive for labelling Animals exposed to Sea-Water over Long Periods

The adhesive, 3*M EC*-1341, has been found to be successful in attaching paper labels to the valves of experimental oysters which were living in a natural salt pond for eight months.

The method of labelling was as follows.

A small (2 cm. × 2 cm.) smooth area of the oyster's valve was scrubbed clean with a brush, washed with fresh water, then with 80 per cent alcohol, and

finally wiped with a dry cloth. Next the oyster was placed either in the sunlight or under a gooseneck lamp for 5–10 min. until the treated area became completely dry. Then the adhesive was applied to the clean, dry surface with a brush. A small (7 mm. × 7 mm.) paper label was placed on this spot and covered with a second application of the adhesive. Again the oyster was set aside to dry, this time for 30 min. or until the sticky fluid became completely dry and hard. The oyster was then placed, with others in the series, in a wire cage which was submerged in the water of a natural salt-pond. When the oysters were examined at the end of an eight-months period all the labels (fifty oysters) were firmly attached and easily readable.

The labels were cut to the desired size from regular filing cards and the appropriate data were marked upon them with a sharp but soft lead pencil.

This method is by far the most successful of any of the various means of labelling which have been tried in the past. First, the labels remain attached for the longest period of time. Secondly, the numbers can be marked on the paper labels with a fine-pointed pencil before the labels are stuck on to the valve. This is a great advantage over using a wax crayon, small paint-brush or pen upon either the surface of the valve itself or upon adhesive tape already adhering to the relatively rough surface of the valve. Furthermore, the second coat of adhesive protects the identification numbers so that they are as easily read after eight months as the day they were written. Their appearance suggested that they would remain in this condition for many more months.

The adhesive 3*M EC*-1341 is a liquid which, if it becomes too thick for easy application, can be diluted with acetone. However, the container should be kept closed whenever the adhesive is not being used. The adhesive was kindly given by the Minnesota Mining and Manufacturing Co., 700 Grand Avenue, Ridgefield, New Jersey.

J. T. Conover

U.S.F.W.S.,
Woods Hole, Mass.

M. E. Pierce

Vassar College,
Poughkeepsie, New York.

## An Interfacial Barrier observed during Liquid–Liquid Extraction of Uranyl Nitrate

Earlier investigations on the transfer of solutes across liquid–liquid interfaces in a stirred cell[1,2] have been extended to a study of the transfer of uranyl nitrate, in both directions, between water and three solvents, dibutyl carbitol, methyl *iso*butylketone (hexone) and tributyl phosphate; the last-named was used as 20 per cent solutions in the inert diluents, 'odourless kerosene', benzene, and carbon tetrachloride. The same apparatus was used as previously described, the two phases, contained in the upper and lower compartments of the transfer cell, being stirred independently. An annular gap between the two compartments enabled the interface to be constrained to a fixed plane of known area. A rigorous study of the hydrodynamics of this transfer cell had already been made[1], so that it was possible to compute the diffusional resistances on each side of the interface for any stirring conditions. The stirring-rates used were sufficiently high for transfer to and from the interface to take place by eddy diffusion, molecular diffusion being negligible.

With the dibutyl carbitol–water and hexone–water systems the observed 'overall' mass-transfer coefficients for transfer in either direction were initially generally either in good agreement with the values calculated assuming the diffusional resistances to be the rate-controlling processes or else somewhat higher. As in the earlier work the higher rates were found to occur in those systems where interfacial turbulence arose[2,3]. These results appear to indicate that initially there is no significant interfacial barrier present. It was found, however, that the rate of transfer fell off markedly during each experiment, eventually reaching values of about a fifth of the initial value. The final slow rate, which in any particular system was substantially independent of concentration, corresponded to an apparent interfacial barrier several times larger than the eddy diffusional resistances. In the case of the dibutyl carbitol–water system experiments were carried out at 50°, as well as 20°; but the final slow rate was independent of temperature. The transfer of uranyl nitrate from water to the tributyl phosphate solutions was also initially controlled by eddy diffusion and the rate fell off as before to a slow final value independent of concentration. With transfer in the reverse direction, however, slow rates corresponding to an interfacial barrier were always obtained.

The reciprocal of the transfer-rate is equivalent to a transfer resistance so that the difference between the reciprocals of the observed and calculated rates gives the value of the additional interfacial resistance. This, of course, is equal to the reciprocal of an interfacial transfer-rate. Typical variations of the resistance with time are shown in Fig. 1.

The transfer of uranyl nitrate between the dibutyl carbitol–water and hexone–water phases has been previously studied by Murdoch and Pratt[4], in a

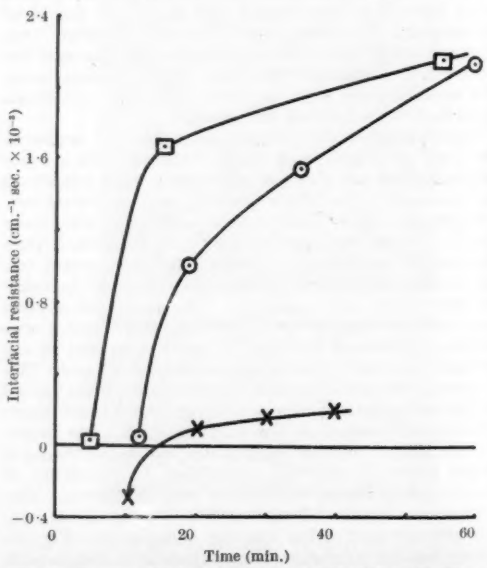



Fig. 1. Increase of interfacial resistance with time: ⊡—⊡—, water → tributyl phosphate/kerosene; ⊙—⊙—, dibutyl carbitol → water; ×—×—, hexone → water (interfacial turbulence)

'wetted wall' column in which the interface was continuously being renewed. An interfacial resistance was shown to be present; but the interfacial transfer coefficients reported were greater than those obtained in this work, for example, about 0·015 cm./sec. as compared with final values of about 0·001 cm./sec. This difference might conceivably be due to the rapid renewal of the interface in the wetted wall column, each element of which is replaced in a few seconds, as compared with the increasing age of the interface in the transfer cell.

A study of the extraction of uranyl nitrate from water into a hydrocarbon solution of tributyl phosphate has recently been carried out by Hahn[5]. Neither phase was stirred, so that transfer to the interface was by molecular diffusion. No interfacial barrier could be detected; but as molecular diffusion is considerably slower than eddy diffusion, a barrier sufficiently large to affect the rate of transfer in stirred systems might be undetectable in Hahn's experiments.

All attempts to provide a theoretical explanation for the fall-off in rate have so far been unsuccessful; however, it has been shown that the effect is real and not due to surface contamination.

I wish to thank Mr. A. S. White for his continued interest in this work and Dr. H. R. C. Pratt for much useful discussion.

J. B. Lewis
Atomic Energy Research Establishment,
Harwell, Didcot, Berkshire.
March 27.

[1] Lewis, J. B., *Chem. Eng. Sci.*, **3**, 248 (1954).
[2] Lewis, J. B., *Chem. Eng. Sci.*, **3**, 260 (1954).
[3] Lewis, J. B., and Pratt, H. R. C., *Nature*, **171**, 1155 (1953).
[4] Murdoch, R., and Pratt, H. R. C., *Trans. Inst. Chem. Eng.*, **31**, 307 (1953).
[5] Hahn, H. T., HW-32626, 20.7.54 (unclassified publication of the U.S.A.E.C.).

## Relation between the Volume of a Liquid and its Internal Energy

In a recent paper[1], Benninga and Scott have pointed out that an adequate theory of liquids must account for the approximate identity, $EV$ = constant. $E$ is defined as being equal to the difference between the internal energy of the substance in the perfect gas state and in the liquid state at a given temperature, and will be identified with the potential energy between the molecules: $V$ is the molar volume of the liquid. We wish to point out that this relationship can be made a direct consequence of the simplest form of 'hole' theory. Although only the case of spherical molecules of a single species will be considered here, it is intended that a treatment generalized to include the case of mixtures of non-spherical molecules will be published elsewhere in the near future.

Although the molecules in the liquid state do not in general display long-range order, 'short-range' order is known to exist: thus there is a fairly clearly defined distance $l$ between the centres of molecules which are nearest neighbours. The expansion of such a liquid with change of temperature or pressure can be considered from two extreme points of view: either the distance between all the molecules may alter, resulting in a uniform stretching of the whole liquid structure, or the distance $l$ may remain constant and vacant sites may appear in the ring of nearest neighbours surrounding each molecule. The former theory—uniform stretching—leads, on the basis of a Lennard–Jones 6–12 intermolecular potential, to the law[2] $EV^2$ = constant. In order to investigate the implications of the second theory, two simplifying assumptions will be made: (*a*) that the vacant sites are randomly distributed throughout the body of the liquid; (*b*) that the vacant sites (or 'holes') are equal in size to a molecule.

Let there be $h$ such sites and $N$ molecules, and let $\epsilon$ be the interaction energy due to each pair of molecules which are nearest neighbours. Longer-range interactions will be neglected. Then

$$E = \tfrac{1}{2}NZ\epsilon \times \text{(proportion of nearest neighbour sites which are occupied by molecules)}$$

$$= \tfrac{1}{2}NZ\epsilon N/(N + h)$$

$$= \tfrac{1}{2}NZ\epsilon V'/V$$

where $V'$ is the molar volume of the hole-free lattice, and $V$ is the molar volume of the liquid.

Thus this method of expansion leads to the required relationship $EV = \tfrac{1}{2}NZ\epsilon V'$ = constant.

M. B. King
R. F. Strickland-Constable
Department of Chemical Engineering,
Imperial College,
London, S.W.7.
Feb. 24.

[1] *J. Chem. Phys.*, **23**, 1911 (1955).
[2] Benson, *J. Chem. Phys.*, **15**, 367 (1947).

## Production of Carrier-free Cobalt-58 by Pile Irradiation of Nickel

In the course of a study of neutron–proton reactions in the Harwell pile, we have irradiated nickel metal both in the ordinary irradiation facilities and in a hollow uranium bar. In this bar the energies of the fast neutrons available approximate to the spectrum of fission-neutron energies.

The yields of cobalt-58 obtained are shown in Table 1; the fast-neutron fluxes were measured by counting phosphorus-32 formed in sulphur monitors irradiated at the same time as the nickel, assuming a cross-section of 0·03 barn, as given by Hughes[1], for the reaction sulphur-32 $(n,p)$ phosphorus-32.

We have separated cobalt-58 from irradiated nickel in a carrier-free state, obtaining about 80 per cent yield. The nickel was dissolved in nitric acid, the solution evaporated to dryness, and the residue taken up in 9 $N$ hydrochloric acid. This solution was added to a column of 'De Acidite FF' anion-exchange resin, when the nickel passed through and the cobalt was adsorbed. When all the nickel had been removed

Table 1

| Irradiation | Fission neutron flux (neutrons/cm.²/sec.) (S$(n,p)$ $^{32}$P monitors) | Saturation activity (mc./gm. Ni) | Cross-section (Ni-58) (millibarns) | Cross-section (Ni metal) (millibarns) |
|---|---|---|---|---|
| Hollow slug, 9 days | 4·9 × 10¹¹ | 4·4 | 47 | 31·5 |
| Thermal flux, 1·4 × 10¹³ ($n$/cm.²/sec.), 6·4 days | 2·7 × 10¹¹ | 2·3 | 45 | 31 |
| Thermal flux, 1·2 × 10¹³ ($n$/cm.²/sec.), 6·4 days | 2·3 × 10¹¹ | 1·9 | 44 | 30 |
| Thermal flux, 1·0 × 10¹³ ($n$/cm.²/sec.), 6·4 days | 2·0 × 10¹¹ | 1·7 | 44 | 30 |

with more 9 *N* hydrochloric acid, the cobalt was eluted with water and dilute ammonia[2].

From 5 gm. of spectroscopically pure nickel irradiated for eighteen months a solution of cobalt-58 was obtained with the following characteristics, extrapolated back to the end of irradiation (assuming a half-life for cobalt-58 of 70 days).

| | | |
|---|---|---|
| Activity | = | 33·6 millicuries |
| Volume | = | 50 ml. |
| Nickel concentration | = | < 0·2 p.p.m. of solution |
| Cobalt concentration | = | < 0·4 p.p.m. of solution |
| Specific activity | = | > 1,680 curies/gm. cobalt |

The cobalt concentration was below the lower limit of the spectrographic and spectrophotometric methods used for its determination. In this specimen of cobalt-58 there was present 0·06 per cent cobalt-60 at the end of irradiation; as the maximum estimated cobalt in the solution would produce only 0·03 per cent cobalt-60 by $(n,\gamma)$ reaction, 0·03 per cent at least must be due to the reaction nickel-60 $(n,p)$ cobalt-60. This gives a cross-section for this reaction of between 3 and 7 millibarns.

No other radiochemical impurities have been found in the cobalt-58, either by $\beta+$ absorption in aluminium, rate of decay, or by examination with a $\gamma$-scintillation spectrometer.

The cross-section for fission neutrons of 47 m.barns for the reaction nickel-58 $(n,p)$ cobalt-58 is the highest recorded for a reaction of this type, the next highest being that of sulphur-32 $(n,p)$ phosphorus-32 at 30 mb. It is about four times the cross-section calculated from consideration of mass differences and proton penetrability in the way described by Hughes[3].

An absolute determination of the radioactivity of one cobalt-58 solution was obtained by coincidence measurements and by counting positrons in a $4\pi$ Geiger counter, the source being covered with 260 $\mu$gm./cm.$^2$ of aluminium to cut out Auger electrons. A branching ratio of 15 per cent for positrons was assumed, and an accuracy claimed of $\pm$ 5 per cent. Other cobalt-58 solutions were referred to this one by comparing peak heights obtained for the 0·81 MeV. $\gamma$-ray on a $\gamma$-scintillation spectrometer.

We should like to thank Dr. R. A. Allen, of the Physics Group of the Isotope Division, for providing a standard phosphorus-32 solution, and for standardizing a cobalt-58 solution, and Mr. F. Birks for spectrographic analysis of our cobalt-58 solution.

C. E. Mellish
J. A. Payne

Atomic Energy Research Establishment,
Harwell, Didcot, Berkshire.
April 16.

[1] Hughes, D. J., "Pile Neutron Research", 100 (Addison-Wesley, Cambridge, Mass., 1953).
[2] Kraus, K. A., and Moore, G. E., *J. Amer. Chem. Soc.*, **75**, 1460 (1953).
[3] Hughes, D. J., "Pile Neutron Research", 94–97.

## Ca II Emission Lines in the Twilight Spectrum

Spectra obtained at Saskatoon during the summer of 1955 showed sharp emission lines of wave-lengths 3933·8 A. and 3968·4 A. $\pm$ 0·2 A. to be present at times in the twilight. The spectra were obtained with two Schmidt spectrographs of dispersion 20 A./mm. and 10 A./mm. A microphotometer tracing of a twilight plate obtained on July 14 is shown in Fig. 1.

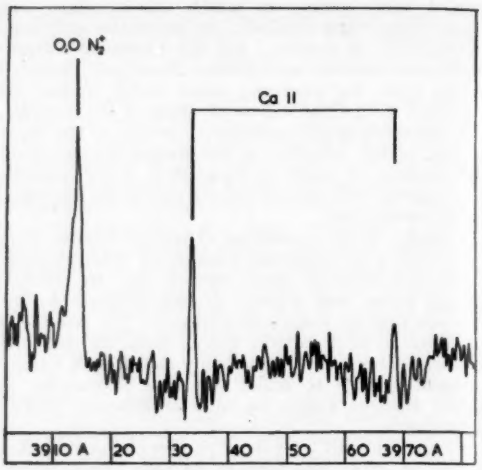



Fig. 1. Microphotometer tracing of twilight spectrum obtained July 14, 1955

The wave-lengths of the *H* and *K* lines of ionized calcium are 3933·7 A. and 3968·5 A. Comparison of the measured wave-lengths with the "M.I.T. Wavelength Tables"[1] showed that no other element besides Ca II could give rise to both emission lines. A measured intensity ratio of 2·1 $\pm$ 0·5 is consistent with the identification with Ca II. The theoretical intensity ratio in the absence of self-absorption for a non-selective excitation process is 2. For a resonance excitation process due to sunlight, as is suggested below, the ratio will be reduced slightly since there will be less energy available in the solar continuum at the wave-length of the stronger line than at that of the weaker. The variation in the intensity of the solar continuum is, of course, due to the *H* and *K* Fraunhofer absorption lines.

The twilight spectra were obtained by directing the 'line of sight' of the spectrograph so that it intersected the boundary between the illuminated and dark regions of the atmosphere at a constant height of 100 km. (neglecting atmospheric refraction). Exposures of three hours or more in one night are possible at Saskatoon in midsummer. The altitude and azimuth of the line of sight must, of course, be varied continuously according to a precalculated programme. The zenith angle varied from 30° to 85°.

It was found that the emission was not present with constant intensity. A continuous programme of observation was therefore carried out from early July until December. The results of this series of spectra

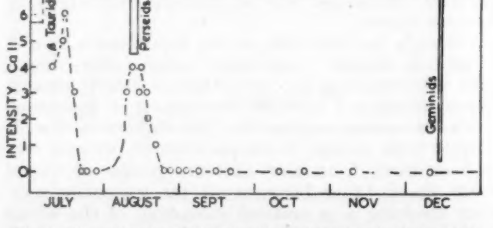



Fig. 2. Eye estimates of the intensity of Ca II lines in the twilight spectrum obtained during months of July–December, 1955. The times of the principal meteor showers occurring during this period are indicated in the upper part of the graph

are shown graphically in Fig. 2. Each point represents a satisfactorily exposed plate. Most of the later plates were exposed for two or more days; the median date is indicated. It will be noticed that the emission lines disappeared by the end of July but reappeared strongly about August 9–10. The intensity then decayed steadily over a period of about ten days; no further reappearance of the line was detected.

While the lines were observable, two exposures were programmed for a height of 80 km. and two for a height of 120 km. No emission was detected for the 80 km. spectra whereas the plates for 120 km. showed the lines with measurable intensity. There is thus some evidence for supposing that the emission may be concentrated in the region 100–120 km.

The question as to whether or not the emission is primarily a twilight phenomenon was investigated by exposing five plates to the morning and evening twilight for one half of the slit and to the night sky (and aurora) for the other half of the slit. Two of these plates obtained over the period August 11–12 showed the Ca II emission lines to be present also in the night sky and aurora; indeed, the emission was stronger in the latter section of the plate. In the case of these two plates it is not possible to be sure whether the emission was really associated with the night sky or aurora. The spectrograph which was directed towards the lower part of the northern sky may have received some residual twilight radiation from higher atmospheric levels or may even have recorded the Ca II lines emitted directly from meteor trails. However, in the three other plates obtained during the period of declining activity in August, the lines were observed only in the twilight and were absent in the night sky and aurora.

The most reasonable interpretation of the above results is that the observed emission is due to a resonant excitation of the calcium ions by sunlight analogous to the well-known twilight spectrum of sodium. The intermittent appearance of the emission would possibly suggest that the calcium was of meteoric origin. In Fig. 2, the dates of the principal meteor showers are indicated[2]. There is a striking correlation between the August reappearance of the calcium emission and the Perseid meteor shower. The earlier appearance of the emission may have been connected with the day-time meteor activity occurring in June and early July. Further observations planned for the coming summer should enable a definite decision to be reached on this point. The failure to observe any twilight emission in December at the time of the Geminid meteor shower is not very significant since no exposures were obtained between December 7 and December 18, whereas the meteor shower has its maximum intensity about December 13–14.

The heights quoted above are derived from calculations of the position of the shadow of the surface of the Earth neglecting the effect of the atmosphere. Two corrections must be made to these results. The first is that due to atmospheric refraction which tends to lower the shadow boundary by 20–30 km. The second correction is that due to the high extinction coefficient of the lower regions of the atmosphere for radiation of wave-length 4000 A.; as a consequence of this effect some higher level of the atmosphere rather than the surface becomes effective in casting the shadow. The latter effect consequently tends to raise the effective shadow height. It is quite likely that in this case these two corrections may cancel one another.

The maximum absolute surface brightness, $B$, of the stronger line referred to the zenith was estimated provisionally to lie between $0{\cdot}4$ and $2{\cdot}4 \times 10^6$ photons cm.$^{-2}$ sec.$^{-1}$ steradian$^{-1}$. In terms of the recently proposed new unit, the rayleigh[3], this brightness corresponds to a value of $4\pi B$ between 5 and 30 rayleighs. An extinction coefficient of $0{\cdot}10$ km.$^{-1}$ was taken for the atmosphere at 4000 A., following the results of Baum and Dunkelman[5].

I am indebted to Dr. D. M. Hunten for valuable discussions on the subject of twilight spectra.

The investigation reported here has been sponsored by the Geophysics Research Directorate of the U.S. Air Force Cambridge Research Center, Air Research and Development Command, under Contract *AF* 19(122)-152.

A. Vallance Jones

Physics Department,
University of Saskatchewan,
Saskatoon, Sask.
May 22.

[1] "M.I.T. Wavelength Tables" (Wiley, New York, 1939).
[2] Lovell, A. C. B., "Meteor Astronomy", 391 (Oxford Univ. Press, 1954).
[3] Hunten, D. M., Roach, F. E., and Chamberlain, J. W., *J. Atmos. Terr. Phys.* (in the press).
[4] Hunten, D. M., *J. Atmos. Terr. Phys.*, **5**, 44 (1954).
[5] Baum, W. A., and Dunkelman, L., *J. Opt. Soc. Amer.*, **45**, 166 (1955).

## Sudden Absorption of Atmospherics due to Increase in Cosmic Ray Intensity

An effect of the solar flare and cosmic ray increase of February 23 reported by several observers[1–4] was recorded on the atmospheric noise study apparatus located at the U.S. Air Force Cambridge Research Center site at Fourth Cliff, in Scituate, Mass.

The sudden absorption of energy that occurred is of interest because it was recorded during the night. The night-time absorption appears to be directly related to the cosmic ray increase.

The apparatus consisted of a whip antenna feeding a receiver, set at a frequency of 49 kc./s. The output of the intermediate-frequency amplifier was fed into a probability computer designed and built by the University of Florida. A milliammeter recorded the percentage of time that the electric field intensity exceeded the threshold voltage set on the computer. The level on the accompanying illustration is such that an input of 2 μV. exceeds the threshold voltage 50 per cent of the time when the chart time reads at the middle of the scale. The time constant of the unit was 16 sec.

Fig. 1 illustrates the absorption of signal taking place at approximately the time of observation of the

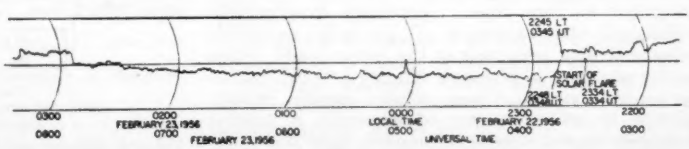



Fig. 1

flare. The exact sequence of time was as follows: The flare was observed in Tokyo at 0334 U.T. February 23. At 0340 U.T. an S.I.D. was reported. The drop in signal-level of the 49 kc./s. atmospherics started at 0344, a few minutes earlier than the beginning of the cosmic ray increase noted at 0348 at Cheltenham, 0350·3 at Chicago, and 0353 at Godhavn, Greenland. At 0343 Pierce and Moritz[4] observed at Cambridge, Mass., an increase in the rate of change of phase of 16 kc./s. signals from Rugby, England.

The time lapse involved between the S.I.D. and the sudden absorption of atmospherics (4 min.) and the fact that the event occurred at 2244 local time seems to indicate that the disturbance observed was produced by the cosmic ray increase rather than being connected with the S.I.D. produced by the ultraviolet. Considering the geometry of the situation it seems unlikely that the decrease in signal-level was due to the increase in absorption of atmospherics in the sunlit portion of the globe, because observations were made around the period of local midnight.

The signal intensity decreased to its daylight value within the period of 5 minutes. It returned to its pre-absorption level at 0830 U.T. or 0330 L.T. At this time the Cheltenham and Godhavn cosmic ray increases were down to about the same level as their pre-flare value, while the Chicago amplitude had declined to approximately 200 per cent of its pre-flare level (it had increased by a factor of eighteen times). The time of onset of the sudden absorption and the rise to pre-flare value of the 49 kc./s. signal-level both indicate a close correlation with the sudden increase in cosmic ray intensity on the dark side of the Earth.

Considering the path taken by the cosmic ray particles and the ionization produced, it might be of interest to consider the role of the steady-state particles in producing the night-time ionosphere.

Jules Aarons
William R. Barron

Electronics Research Directorate,
Air Force Cambridge Research Center,
L. G. Hanscom Field,
Bedford, Mass.
June 11.

[1] Forbush, Scott E., *J. Geophys. Res.*, **61** (March 1956).
[2] Shapley, A. H., and Roberts, W. O., U.R.S.I. Meeting, Washington, D.C. (Spring 1956).
[3] Meyer, P., and Simpson, J. A., *Phys. Rev.* (in the press).
[4] Pierce, J. A., and Moritz, Mrs. E. H., Cruft Lab. Progress Report 39; Project III-4, Contract *N50RI-76* (April 1, 1956).

## Representation of the Inelastic Deformation of Concrete by means of a Mechanical Model

The non-linearity of the relation between the stress and the strain of concrete at high loads was observed by many of the early workers in the field of reinforced concrete research at the turn of the century. It is, however, doubtful whether the difference between non-linear elasticity and inelastic behaviour was fully recognized at that time. Glanville's experiments[1] established the existence of partially reversible inelastic strains, occurring at the lowest loads, which are for all practical purposes directly proportional to the concrete stress. These inelastic strains, usually referred to as creep, are consequently a viscous phenomenon, and rheological models have been constructed[2–4] to describe the visco-elastic deformation of concrete. Models of this type have satisfactorily explained the deformation of concrete subject to moderate loads over long periods of time; however, they fail to account for the observed relation between stress and strain in concrete tested to destruction at a constant rate of strain. Since 1938 stress-strain diagrams obtained from individual test pieces have been reported from time to time, which show a descending portion terminating at a relatively high ultimate strain. Both phenomena have now been confirmed by a systematic investigation[5].

Freudenthal[6] has suggested that the departure of the concrete stress–strain diagram from visco-elastic behaviour is due to breakdown of the adhesion between the cement and the aggregate. This is confirmed by the observation of minute cracks at about 60 per cent of the ultimate load by Berg[7] using an optical method, and by Jones[8] using an ultrasonic method; the presence of micro-cracks has also been inferred from tensile tests by Blakey and Beresford[9]. These considerations lead to the statistical concept of a concrete specimen made up of a number of elements with strengths distributed over a specific range. Williams and Kloot[10], working on the behaviour of timber specimens in tension, have produced a mathematical theory for a model of this type.

The mechanical model shown in Fig. 1 has been devised to reproduce the various features of the elastic and inelastic deformation of concrete referred to. It consists of two series of viscous dashpots and elastic springs in parallel, the dashpot of one of the units being blocked by non-return valves; and a series of brittle springs in parallel which behave elastically up to failure, the failing loads of these springs being distributed over a range. When this model is deformed by a moderate load, so that the brittle springs are not damaged, it exhibits an immediate elastic deformation proportional to the applied load, and a progressive inelastic deformation at a decreasing rate, the total inelastic deformation over an infinite period being proportional to the applied load. When the model is unloaded the procedure is reversed; but due to the blocking of the second dashpot some of the inelastic deformation is not recovered. When the model is loaded sufficiently rapidly to produce negligible deformation of the dashpots, it deforms elastically until the fracturing load of the weakest brittle spring is reached, and the subsequent inelastic deformation is irreversible. A typical load-deformation diagram of a model under these conditions is shown in Fig. 2, and this is very similar to the experimental stress-strain diagrams for concrete tested rapidly at a constant rate of strain which have been referred to. When the model is deformed sufficiently slowly to allow for appreciable deformation of the dashpots, and the load is carried

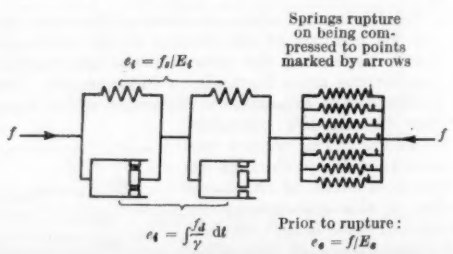



Fig. 1. Comprehensive mechanical model for the elastic and inelastic deformation of concrete

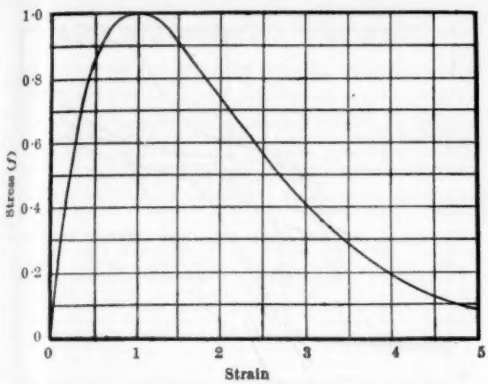



Fig. 2. Load-deformation curve produced by the mechanical model in Fig. 1 when it is deformed sufficiently rapidly to produce negligible viscous deformation. (Expressed in terms of the maximum stress and strain)

at the same time above the fracturing load of the weaker brittle springs, then both types of inelastic deformation are reproduced.

Apart from the quantitative determination of the inelastic deformation of concrete, the model may assist the qualitative examination of the long-term behaviour of concrete under load. The recent successful application of the theory of plasticity to structural steel design has focused attention on the development of a similar theory for reinforced concrete structures. The plastic deformation of steel, like the viscous deformation of concrete, does not constitute structural damage although it results in permanent and frequently serious distortion of the structure. The deformation of concrete at high loads due to the formation of micro-cracks, on the other hand, results in structural damage which can be repaired only by chemical action over long periods. It has been established that stress relation due to creep over long periods increases the capacity of redundant structures to carry sustained working loads. Furthermore, the high inelastic strains due to micro-crack formation increase the load-bearing capacity in a continuous test to destruction. It cannot, however, be assumed that inelastic deformation increases the load-bearing capacity of a reinforced concrete structure for all combinations and sequences of loading.

HENRY J. COWAN

Department of Architectural Science,
University of Sydney.
Feb. 6.

[1] Glanville, W. H., Dept. Sci. Ind. Res., Bldg. Res. Tech. Paper, No. 12 (London, 1930).
[2] Ross, A. D., *J. Inst. Civ. Eng.*, **21**, 38 (1943).
[3] Arnan, M. A., Reiner, M., and Teinowitz, M., "Research on Loading Tests of Reinforced Concrete Floor Structures" (Research Council of Israel, Jerusalem, 1950).
[4] Torroja, E., and Paez, A., "Building Materials, their Elasticity and Inelasticity", Chap. 8 (ed. M. Reiner, North Holland Publishing Co., Amsterdam, 1954).
[5] Hognestad, E., Hanson, N. W., and McHenry, D., *J. Amer. Conc. Inst.*, **27**, 455 (1955).
[6] Freudenthal, A. M., "The Inelastic Behaviour of Structures" (John Wiley and Sons, New York, 1950).
[7] Berg, O. Y., *Dokl. Akad. Nauk. SSSR.*, **70**, 617 (1950).
[8] Jones, R., *Brit. J. App. Phys.*, **3**, 229 (1952).
[9] Blakey, F. A., and Beresford, F. D., Com. Sci. Ind. Res. Org., Div. Bldg. Res., Rep. No. C.2.2-2 (Melbourne, 1955).
[10] Williams, E. J., and Kloot, N. H., *Aust. J. App. Sci.*, **3**, 1 (1952).

## Creep in Coal at Room Temperature

THE deflexion of a cantilever of a bituminous coal (Barnsley Hards) has been found to increase steadily with time under a constant load well below the rupture value. This movement is taken to be evidence of the phenomenon known as creep.

A typical graph showing the relationship between the deflexion of a cantilever of Barnsley Hards and the duration of loading is shown in Fig. 1. The deflexion $d$ satisfies an equation of the form:

$$d = A + B \log t + Ct$$

where $t$ is the duration of loading. This is similar in form to the equation used by Griggs[1] to represent the deformation of a cube of rock subjected to uniaxial compression.

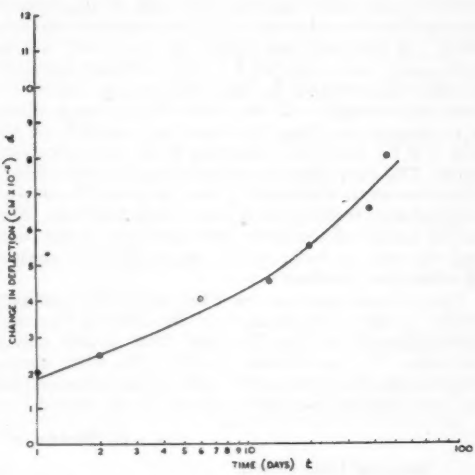



Fig. 1. Change of deflexion with time of a loaded cantilever of Barnsley Hards. Curve gives $d = 1{\cdot}95 + 1{\cdot}82 \log t + 0{\cdot}051\,t$. Specimen dimensions (cm.): width, 1·62; thickness, 0·24; unsupported length of cantilever, 8·5. Applied load, 31·4 gm. $\eta_c = 4{\cdot}81 \times 10^{16}$ poises

In like manner, the recovery of the cantilever when unloaded satisfies the equation:

$$d = A + B_1 \log t$$

used by Griggs for the recovery of cubes. The logarithmic term can be interpreted as a pseudo-elastic or recoverable creep and the linear term $Ct$ as a pseudo-viscous creep. Using this subdivision, the creep viscosity $\eta_c$ of Barnsley Hards coal at room temperature has been estimated to be of the order of $10^{16}$–$10^{17}$ poises, compared with $10^{20}$–$10^{22}$ poises obtained by Griggs for limestone. This comparison may not be strictly valid, since Griggs obtained his results from compression tests.

In similar experiments at the same sensitivity of observation, no creep of anthracite was observed.

Although Barnsley Hards and anthracite have closely similar compressive strengths across the bedding planes (about 8,000 lb./in.$^2$ for 1-in. cubes), they are easily distinguishable by the manner in which they break. Anthracite breaks into conchoidal

fragments which frequently have razor-sharp edges, whereas the Barnsley coal breaks into more regularly shaped pieces with less acute edges. In general, cubes of both coals break explosively when they are compressed between flat platens; but it has been found possible to induce non-explosive breakage in the Barnsley coal provided extremely low rates of straining are used. No matter how slowly the anthracite cubes have been loaded, explosive breakage has always occurred. These differences are probably related to the rheological properties of the coals, and in particular to the presence or absence of creep.

Somewhat analogous to the explosive breakage of cubes are the violent outbursts of coal from the seam which occasionally occur. These outbursts have occurred in many areas, but there is strong evidence that in the United Kingdom they are most prevalent in the anthracite areas. Outbursts have been attributed to many factors, but high in importance among these would seem to be the nature of the coal itself. If the coal can creep, the roof load will be more easily accommodated as the workings advance, so that the stresses in the coal remain below the breaking strength. If the coal cannot creep, there is a greater risk that the breaking strength of the coal will be exceeded, resulting in an explosive outburst. This may offer an explanation of the prevalence of outbursts in anthracite; but it would be unwise to generalize further since other considerations, such as the nature of the floor, the thickness of the seam and the rate of build-up of the overburden stresses all affect the problem.

This communication describes work forming part of the research programme of the Mining Research Establishment of the National Coal Board and is published by permission of Dr. W. Idris Jones, director-general of research. The views expressed are my own and not necessarily those of the Board.

C. D. Pomeroy

National Coal Board,
Mining Research Establishment,
Worton Hall,
Worton Road, Isleworth.

[1] Griggs, D. T., *J. Geol.*, **47**, 225 (1939).

## Photographic Sensitizers in Gelatin

Thirty years ago, Sheppard[1] isolated allyl *iso*-thiocyanate from extracts of photographically active gelatins. It has since been made evident that this sulphur sensitizer is not usually present in gelatins produced by existing methods. Steigmann[2] has demonstrated by chemical tests the presence in lime-treated hide gelatins of thiosulphate and trithionate ions, and has indicated a mode of formation of these sensitizing substances by alkaline degradation of cystine. Wood[3,4] has applied paper chromatography and paper electrophoresis to extracts from gelatins, and has detected thiosulphate and polythionates. He has suggested alternative mechanisms of sensitizer formation, including oxidation of sulphides used for depilatory purposes in gelatin precursor treatment, and also oxidation or autoxidation of sulphur dioxide. The purpose of the present communication is to indicate that a quantitative method has been devised for determining sensitizers in gelatin extracts.

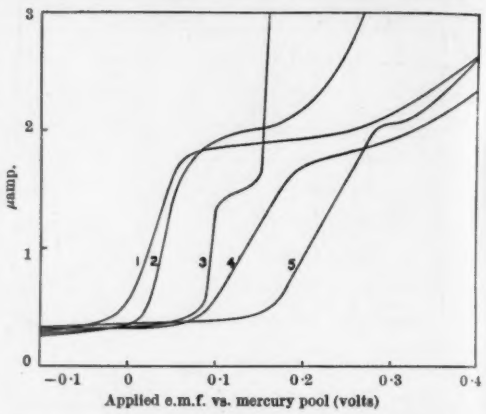



Fig. 1. Anodic polarograms of various sulphur sensitizers in 0·2 *M* potassium nitrate: (1) 0·4 m*M* Thiosulphate. (2) Gelatin extract. (3) 4 m*M* Allyl *iso*thiocyanate. (4) 0·5 m*M* Thiourea. (5) 0·5 m*M* Thiosinamine

The method of extraction was similar to that used by Wood[3], but on a smaller scale; 25 gm. of the gelatin were extracted at 0° C. with a total of about 200 ml. of water, and the extracts were concentrated *in vacuo* to 10 ml. These concentrated extracts have been examined polarographically. Fig. 1 shows the results of anodic polarography in 0·2 *M* potassium nitrate on the extract from a particular gelatin and on some known sensitizers. In making such comparisons, it is essential to compare at roughly the same wave-height, as the substances shown all have a half-wave potential which varies with concentration.

It will be seen that the sensitizer present closely resembles thiosulphate in its behaviour. Cathodically, in 1 *M* ammonium dihydrogen phosphate[5], tetrathionate has been detected in the extract. Apart from their polarographic characteristics, the identification of these constituents is confirmed by the behaviour of the extracts towards anion-exchange resins, and to such reagents as iodine (for the thiosulphate) and sulphite (for the tetrathionate).

This technique is readily applicable to the routine examination of gelatins. In this Laboratory, fifty-two gelatins have been examined in this way, and the conclusions indicated above have been found to be generally valid. Neglecting for the moment the tetrathionate content as of secondary importance[4], the thiosulphate contents of the gelatins tested range from 34 p.p.m. for a very active hide gelatin to 0 for inert gelatins. In general, the thiosulphate contents correlate well with the photographic activities of the gelatins.

This work will be reported in full elsewhere. Thanks are due to the directors of Ilford Limited for permission to publish this communication.

G. Russell

Chemical Research Laboratory,
Ilford Limited,
Brentwood, Essex.
Feb. 13.

[1] Sheppard, S. E., *Phot. J.*, **65**, 380 (1925).
[2] Steigmann, A., *Sci. et Indust. Phot.*, **22**, 441 (1951).
[3] Wood, H. W., *Sci. et Indust. Phot.*, **23**, 209 (1952).
[4] Wood, H. W., *J. Phot. Sci.*, **2**, 154 (1954).
[5] Furness, W., and Davies, W. C., *Analyst*, **77**, 697 (1952).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMISTS and PHYSICISTS (with university degrees) in the Laboratories at Watson House, Fulham, London, S.W.6, to undertake research work on the utilization and design of domestic and industrial gas and coke appliances, particularly on cookers, water heaters, gas and coke fires, refrigerators and industrial apparatus—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting Ref. No. 666/280 (August 9).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (August 10).

ASSISTANT LECTURER (preferably with an interest in applied mathematics) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, University College, Gower Street, London, W.C.1 (August 10).

SENIOR LECTURER (with a good honours degree and industrial and teaching experience) TO TEACH ELECTRICAL ENGINEERING AND ELECTRONICS to at least Higher National Certificate standard—The Principal, College of Electronics, Radar Research Establishment, Ministry of Supply, Great Malvern, Worcestershire (August 10).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least G.C.E. at advanced level) IN THE CHEMISTRY SECTION—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (August 11).

ASSISTANT (graduate in chemistry or biochemistry) IN AGRICULTURAL CHEMISTRY—The Secretary of the University Court, The University, Glasgow (August 18).

LECTURERS (with industrial experience, preferably teaching experience and a special knowledge of one of the following fields: electrical machinery; servos and automatic control; vibration analysis and engineering acoustics; communications (other than radio) IN ELECTRICAL ENGINEERING—The Secretary of the University Court, The University, Glasgow (August 18).

LEVERHULME SENIOR RESEARCH FELLOW (graduate in biochemistry or physiology and preferably experience with bio-assay or radioisotope techniques) to work on the effects of steroid hormones in ruminants, and in particular to investigate the physiological bases for the improvement in growth-rate resulting from hormone treatment—The Registrar, The University, Nottingham (August 18).

LECTURER or ASSISTANT LECTURER (with special interests in inorganic or physical chemistry) IN CHEMISTRY—The Registrar, The University, Sheffield (August 20).

RESEARCH OFFICER (with a university honours degree in science, with biochemistry, chemistry or physical chemistry as a major subject, or equivalent qualifications, and preferably some research experience) IN THE DAIRY RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, Highett, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 410/54 (August 20).

ASSISTANT LECTURER (Grade III) or DEMONSTRATOR IN PHYSIOLOGY (Chemical Physiology)—The Registrar and Secretary, The University, Bristol (August 25).

LECTURER/SENIOR LECTURER IN GEOLOGY at the University of Sydney, Australia, The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 25).

PRINCIPAL (with a degree in engineering or equivalent, and industrial and teaching experience) with the Gold Coast Local Civil Service, to take charge of a Technical Institute—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD. 114/13/01 (August 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, University College of Wales, Aberystwyth (August 31).

CHAIR OF BOTANY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

CHAIR OF CHEMICAL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (August 31).

LECTURER IN THE DEPARTMENT OF GEOLOGY at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (August 31).

LECTURER (with interest and experience in biophysics) IN PHYSIOLOGY—The Secretary, The University, Aberdeen (August 31).

LECTURERS (2) IN ZOOLOGY; a LECTURER IN GEOGRAPHY; a LECTURER IN APPLIED MATHEMATICS; a SENIOR LECTURER IN EDUCATION; and CHAIR OF EDUCATION, at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

LECTURER on the staff of the DEPARTMENT OF PHYSICS, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (September 1).

LECTURER (preferably with research interests and experience in the physics of solids) IN THE DEPARTMENT OF PHYSICS, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (September 1).

READER IN MATHEMATICAL ANALYSIS at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 15).

SENIOR LECTURER, and a LECTURER IN THE DEPARTMENT OF PSYCHOLOGY, Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 15).

LECTURER IN LOGIC AND METAPHYSICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, September 21).

PROFESSOR AND HEAD (with high academic qualifications, and wide experience in research, teaching and industrial processes) OF THE DEPARTMENT OF METALLURGY—The Registrar, Indian Institute of Science, Bangalore, India (September 23).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 24).

CHAIR OF MECHANICAL ENGINEERING at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 29).

CHAIR OF AGRICULTURE at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 30).

ANALYST (with a university degree in chemistry or equivalent qualification in analytical chemistry, for example, A.R.I.C., with two years research experience in pure or applied chemistry) IN THE DEPARTMENT OF AGRICULTURE, Federation of Nigeria, to carry out analysis and testing of soils and plant materials in connexion with the research programme of a Soils and Crop Nutrition Team, and to supervise the routine work in the Chemistry Laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD. 63/14/037.

ASSISTANT WARDEN (with an honours degree in botany, coupled with a general interest in field subjects) at Malham Tarn Field Centre, Near Settle, Yorks—The Secretary and Treasurer, Field Studies Council, Balfour House, 119/125 Finsbury Pavement, London, E.C.2.

CYTOLOGIST (graduate in zoology with an interest in cytology) IN THE CYTOGENETICS GROUP—The Director, Medical Research Council Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Berks.

DEMONSTRATORS IN PHYSICS; and RESEARCH ASSISTANTS IN PHYSICS to work on the magnetic properties of molybdenum permalloy and on the properties of adamantine compounds—The Registrar, The University, Nottingham.

LECTURER or ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Registrar, The University, Nottingham.

PRINCIPAL RESEARCH OFFICER (with a university honours degree in natural science, postgraduate research experience and an aptitude for directing investigational work) IN THE DEPARTMENT OF AGRICULTURE, Federation of Nigeria, to supervise rice research work at the Federal Rice Research Station, and to undertake his own research project—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/14/016.

RESEARCH ASSISTANT (honours graduate in chemistry) IN THE SCHOOL OF CHEMISTRY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

SENIOR LECTURER (preferably with high qualifications and considerable research, industrial or teaching experience, and the ability to develop some branch of applied physics) IN PHYSICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

TECHNICAL ABSTRACTOR (with a degree in chemistry, experience in the preparation of informative abstracts and literature surveys, and ability to translate scientific German) IN THE INTELLIGENCE SECTION—The Intelligence Officer, Coal Tar Research Association, Oxford Road, Gomersal, near Leeds.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

A New Theoretical Basis for *PSI*—addressed to Members of the Society for Psychical Research, 1956. By C. C. L. Gregory and Anita Kohsen. Pp. 36. (Church Crookham, Hants: Institute for the Study of Mental Images, 1956.) 1*s.* net. [175

Department of Agriculture for Scotland. Memoirs of the Soil Survey of Great Britain. The Soils of the Country Round Jedburgh and Morebattle. By J. W. Muir. (Sheets 17 and 18.) Pp. 178+4 plates. (Edinburgh: H.M. Stationery Office, 1956.) 30*s.* net. [175

Building Research Station Digest. No. 87 (April, 1956): Questions and Answers. Pp. 4. (London: H.M. Stationery Office, 1956.) 3*d.* net. [175

World Power Conference. Annual Report, 1955. Pp. 20. (London: World Power Conference, 1956.) [175

British Drug Houses Limited. Report and Accounts, 1955. Pp. 12. (London: British Drug Houses Limited, 1956.) [175

The British Journal Photographic Almanac, 1956. Edited by Arthur J. Dalladay. Pp. 628+32 plates. (London: Henry Greenwood and Co., Ltd., 1956.) 8*s.* 6*d.* net. [185

Lundy Field Society. Ninth Annual Report, 1955. Pp. 43. (Exeter: L. A. Harvey (Secretary), c/o The University, 1956.) [185

Library Association. Pamphlet No. 14: The Development of Public Library Services in the Gold Coast. By Evelyn J. A. Evans. Pp. 32+3 plates. 5*s.* (3*s.* 6*d.* to L.A. members). Pamphlet No. 15: Notes on Cataloguing Books in Certain Foreign Languages. Edited by Mary Piggott. Pp. 53. 7*s.* (5*s.* to L.A. members). (London: Library Association, 1956.) [185

Report of the Panel on Composition and Nutritive Value of Flour. Pp. vii+34. (Cmd. 9757.) (London: H.M. Stationery Office, 1956.) 1*s.* 6*d.* net. [185

Colonial Office. Her Majesty's Oversea Civil Service: Statement of Policy Regarding Organisation. Pp. 4. (Cmd. 9768.) (London: H.M. Stationery Office, 1956.) 4*d.* net. [255

Department of Scientific and Industrial Research and Fire Offices' Committee. Report of the Fire Research Board with the Report of the Director of Fire Research for the year 1955. Pp. viii+57+8 plates. (London: H.M. Stationery Office, 1956.) 4*s.* net. [255

Registrar General's Statistical Review of England and Wales for the year 1954. Part 2: Tables, Civil. Pp. x+176. (London: H.M. Stationery Office, 1956.) 6s. net. [255

*Planning*, Vol. 22, No. 396 (23 May 1956): Secondary Modern Schools. Pp. 69–84. (London: Political and Economic Planning, 1956.) 2s. 6d. [255

Department of Scientific and Industrial Research. National Physical Laboratory Report for the year 1955. Pp. viii+110+7 plates. (London: H.M. Stationery Office, 1956.) 5s. net. [255

British Iron and Steel Research Association. Annual Report, 1955. Pp. 127+13 plates. (London: British Iron and Steel Research Association, 1956.) [255

## Other Countries

The History of the Scientific Club of Winnipeg, 1905–1955 (with List of Present and Former Members and Guests and of Their Communications to the Club). By F. D. White. Pp. 52. (Winnipeg: Scientific Club of Winnipeg, 1956.) [105

Notulae Naturae of the Academy of Natural Sciences of Philadelphia. No. 267 (February 11, 1955): An Unpublished Fish Plate by Lesueur. By Maurice E. Phillips. Pp. 4. No. 268 (March 25, 1955): Some Eocene Reptiles from New Jersey. By Halsey W. Miller, Jr. Pp. 5. No. 269 (March 25, 1955): The Acute Toxicity of Phenol to the Common Bluegill (*Lepomis macrochirus* Rafinesque). By Francesco B. Trama. Pp. 10. No. 270 (March 25, 1955): The Tendipedid Fauna of a Massachusetts Cold Spring (Diptera: Tendipedidae). By Selwyn S. Roback. Pp. 8. No. 271 (March 25, 1955): The Adult of Crypsicerus Cubicus Saussure (Orthoptera: Acrididae: Lathicerinae). By James A. G. Rehn. Pp. 5. No. 272 (March 25, 1955): A New Andean Katydid of the Genus Dichopetala (Orthoptera: Tettigonidae: Phaneropterinae). By James A. G. Rehn. Pp. 5. No. 273 (May 20, 1955): The Brotulid Fish Genus *Petrotyx* from the Great Bahama Bank. By James Böhlke. Pp. 6. No. 274 (May 20, 1955): A New Symbiotic Relationship Involving Molgula Manhattensis (De Kay) and Mya Arenaria L. By Frederick A. Aldrich. Pp. 3. No. 275 (June 10, 1955): Notes on the Neotropical Tetrigid Genus Paurotarsus Hancock, including the Description of Two New Subspecies (Orthoptera: Acridoidea). By Harold J. Grant, Jr. Pp. 14. No. 276 (June 30, 1955): Studies of the Reproductive Functional Morphology of Asteroidians. 1: Sex Reversal in the Common Sea Star, *Asterias Forbesi* (Desor). By Frederick A. Aldrich and Marguerite M. Aldrich. Pp. 2. No. 277 (June 30, 1955): Studies on Fishes of the Family Characidae. No. 9: Notes on the Distribution, Variation and Type Locality of *Gnathocharax Steindachneri* Fowler. By James Böhlke. Pp. 14. No. 278 (June 30, 1955): Studies on Fishes of the Family Characidae. No. 10: Notes on the Coloration of the Species of Hemiodus, Ptero-hemiodus and Anisitsia, with the Description of a New Hemiodis from the Rio Negro at the Brazil–Columbia Border. By James Böhlke. Pp. 15. No. 279 (June 30, 1955): Five Species of Rare Sharks New for Madeira, including Two New to Science. By G. E. Maul. Pp. 13. No. 280 (August 12, 1955): The Effect of Temperature on the Growth of some Fresh-Water Diatoma. By Natalie Mong Wallace. Pp. 11. No. 281 (October, 1955): On the Bahaman Fishes of the Family Opisthognathidae. By James Böhlke. Pp. 6. No. 282 (October 19, 1955): A New Genus of Ophichthid Eels from the Bahamas. By James Böhlke. Pp. 7. No. 283 (December 14, 1955): Notes on Two Sponges from the Tertiary of New Jersey and South Carolina. By B. F. Howell and Horace G. Richards. Pp. 3. No. 284 (December 14, 1955): The Geological History of the Cayman Islands. By Horace G. Richards. Pp. 11. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1955). [105

World Health Organization. Technical Report Series. No. 102: Expert Committee on Drugs Liable to Produce Addiction—Sixth Report. Pp. 21. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 1 Swiss franc; 1s. 9d.; 30 cents. [105

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark. Rapports et Procès-Verbaux des Réunions. Vol. 140, Part 1: Problems and Methods of Sampling Fish Populations. Pp. 111. (Copenhague: Andr. Fred Høst et Fils, 1956.) 25 kronor. [105

Organization for European Economic Co-operation. Ministerial Committee for Agriculture and Food: Committee of Deputies. Report on the Confrontation of Agricultural Policies, 1955—Summary of Present Policies and Future Actions. Pp. 70. Resolution of the Ministerial Committee for Agriculture and Food Concerning the Confrontation of Agricultural Policies. Pp. 4. Resolution of the Ministerial Committee for Agriculture and Food Concerning the Choice of Methods for Relaxing Import Regimes for Apples, Pears and Tomatoes. Pp. 3. (Paris: Organization for European Economic Co-operation, 1956.) [105

Geological Survey of Nigeria. Bulletin No. 25: The Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons. By R. A. Reyment. Pp. ii+112+25 plates. (Kaduna Junction, Nigeria: Geological Survey Department, 1955.) 20s. [145

University of Sydney: School of Agriculture. Report No. 1. Pp. 80. (Sydney: University of Sydney, School of Agriculture, 1955.) [145

Food and Agriculture Organization of the United Nations. Report of the 8th Session of the Conference, 4–25 November 1955. Pp. iv+270. (Rome: Food and Agriculture Organization of the United Nations, 1956.) 15s.; 3 dollars. [145

Untersuchung der Kristallgrenzen in Verformten Metallen, Insbesondre Durch Mikrohärtemessungen. Von Heinrich Eugen Tuchschmid. (These für einem Doktor der Technischen Wissenschaften von der Eidgenössischen Technischen Hochschule in Zurich.) Pp. 50. (Solothurn: Buchdruckerei Vogt-Schild AG., 1954.) [145

East Africa High Commission. East African Agriculture and Forestry Research Organization. Annual Report, 1955; Record of Research for the period 1st January 1954 to 30th June 1955. Pp. ix+116. (Kikuyu: East African Agriculture and Forestry Research Organization, 1956.) 8hs. 3/50. [155

Meddelanden från Oceanografiska Institutet I Göteborg. No. 23: Étude des Teneurs en Manganese et en Carbonates de Quelques Carottes Sedimentaires Atlantiques et Pacifiques. Par G. B. Berrit. Pp. 61. No. 24: Radium in Manganese Crusts. By Viktor St. Kröll. Pp. 12. No. 25: Factors Influencing the Transparency of the Baltic Waters. By N. G. Jerlov. Pp. 19. No. 26: A New Core-Sampler. By B. Kullenberg. Pp. 17. (Göteborg: Elanders Boktryckeri Aktiebolag, 1955.) [15

*Journal of the Textile Machinery Society of Japan*. Vol. 1, No. 1 (November, 1955). Pp. ii+74+58. (Osaka: Textile Machinery Society of Japan, 1955.) 1.50 dollars; 10s. per copy. [15

United States Department of Commerce: National Bureau of Standards. Circular 566: Bibliography of Solid Adsorbents, 1943 to 1953: an Annotative Bibliographical Survey. By Victor R. Deitz. Pp. vi+1528. (Washington, D.C.: Government Printing Office, 1956.) 8.75 dollars. [15

University of Liège: Astrophysical Institute. Atlas of Representative Cometary Spectra. By P. Swings and L. Haser. Pp. 37+23 plates. (Technical Final Report under Contract AF 61 (514)–628. Sponsored in part by the Geophysics Research Directorate of Air Force, Cambridge Research Center, Air Research and Development Command, United States Air Force, through the European Office, ARDC.) (Liège: The University, Astrophysical Institute.) [15

Bulletin of the American Museum of Natural History. Vol. 109, Article 3: Geological Reconnaissance of Raroia (Kon Tiki) Atoll, Tuamotu Archipelago. By Norman D. Newell. (A revision of Bulletin 31 and Bulletin 36 of the Atoll Research Bulletin, Pacific Science Board, Washington, D.C., November 30, 1954.) Pp. 311–372+plates 22–49. (New York: American Museum of Natural History, 1956.) 2 dollars. [175

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 37 (March 1956): The Problem of the Common Cold. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [175

United States Naval Observatory. Circular No. 65: Solar Summary for 1955. Pp. 17. (Washington, D.C.: U.S. Naval Observatory, 1956.) [175

Dinosaurs, Predator and Prey: The Gorgosaurus and Lambeosaurus Exhibit in Chicago Natural History Museum. Pp. 12 (4 plates). (Chicago: Chicago Natural History Museum, 1956.) 25 cents. [175

Building Research in Canada: a Progress Report of the Division of Building Research, National Research Council. Vol. 2, No. 2 (31 December, 1955). Pp. 33–64. (Ottawa: Division of Building Research, National Research Council, 1955.) [185

New Zealand Forest Service: Forest Research Institute. Annual Report of the Forest Research Institute for the year ending 31 March 1955. By H. V. Hinds. Pp. 80. Technical Paper No. 4: (Supplement No. 1): Comparative Tests with Wood Preservatives. By D. R. Carr. Pp. 8. Technical Paper No. 7: A Form Class Volume Table for Exotic Coniferous Species in New Zealand. By E. R. Lewis. Pp. 16. Technical Paper No. 8: The Response of New Zealand Timbers to Fluctuations in Atmospheric Moisture Conditions. By H. R. Orman. Pp. 32. Research Notes. No. 3: Combined Taper and Volume Table for *Pinus ponderosa*—Southland, 1954: Unthinned Stands. *Pinus nigra* var. *calabrica*—Southland, 1954: Thinned Stands. By S. W. Burstall. Pp. 32. No. 4: Air-Drying of New Zealand Grown Corsican Pine Natural Round Fence Posts. By H. R. Orman. Pp. 20. (Wellington: Government Printer, 1955.) [18

Imperial College of Tropical Agriculture. Report of the Governing Body and Principal's Report for 1954–55. Pp. 60. (St. Augustine, Trinidad and London: Imperial College of Tropical Agriculture, 1956.) [25

Meddelanden från Statens Skogsforskningsinstitut, Band 45: I. 1955. (Reports of the Forest Research Institute of Sweden, Vol. 45. II.) Pp. iv+488. Stockholm: Statens Skogsforskningsinstitut, 1956.) [25

Istituto Lombardo di Scienze e Lettere. Rendiconti, Vol. 89. Convegno Antonio Baselli, "Le Macromolecole dei Viventi," Pallanza, 28–30 Luglio, 1955. Pp. viii+348. (Milano: Istituto Lombardo di Scienze e Lettere, 1955.) [25

31. Deutsche Pflanzenschutz-Tagung der Biologischen Bundesanstalt für Land- und Forstwirtschaft in Kassel, 10–14 Oktober, 1955. (Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Heft 85, März 1956.) Pp. ii+204+2 plates. (Berlin und Hamburg: Verlag Paul Parey, 1956.) [25

A Guide to the Assessment of Wattle Bagworm Infestations. By L. L. J. Ossowski. Pp. 8+8 plates. (Pietermaritzburg: South African Wattle Growers' Union, 1956.) [25

Bibliotheque Nationale, Institut de Bibliographie. Bibliographie des Articles Parus dans les Periodiques Turcs. 1954, 1–3, Janvier-Mars. Pp. 155. (Istanbul: Maarif Basimevi, 1956.) [25

United States Department of Agriculture. Leaflet No. 403: Chiggers: How to Fight Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1956.) 5 cents. [25

Food and Agriculture Organization of the United Nations. FAO Forestry Development Paper No. 10: Tree Planting Practices in Temperate Japan. Pp. xii+156. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1956.) 7s. 6d.; 1.50 dollars. [25

*Editorial and Publishing Offices of "NATURE"*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

*Advertisements only should be addressed to*
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office